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The Evaluation of *Staphylococcus aureus* Nasal Colonization in Patients with Acute Folliculitis: A Case-control Study

Akut Folikülit Tanılı Hastalarda *Staphylococcus aureus* Nazal Taşıyıcılığın Değerlendirilmesi: Olgu Kontrol Araştırması

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ABSTRACT Objective: The prevalence and incidence of *Staphylococcus aureus* nasal carriage vary according to the population studied. It is known that there is a link between recurrence of staphylococcal skin infections and nasal carriage. The study aimed to determine the prevalence of *S. aureus* nasal carriage and microbiological profile of the nasal cultures in patients with acute folliculitis without a history of recurrence, to compare the results with the control group, and to evaluate the demographic factors on bacterial growth. **Material and Methods:** A case-control study was conducted in a secondary state hospital between May and August 2021. A total of 120 patients diagnosed with acute folliculitis in a dermatology outpatient clinic were enrolled in the study. Patients' demographics including age, gender, job, having a family history of folliculitis, history of visiting a barber regularly, having a health care worker in the family, and localization sites of folliculitis were recorded. Patients' and control groups' microbiological data from nasal swab cultures were also recorded. **Results:** There was bacterial growth in 29.1% of the patients' nasal cultures. Methicillin-sensitive *S. aureus* was the most frequently isolated microorganism both in the patient and control groups. There was no statistical difference between patients and controls in terms of microbiological profiles and bacterial growth in nasal swab culture. **Conclusion:** *S. aureus* nasal colonization of patients with acute folliculitis has similar rates with the healthy population. *S. aureus* nasal carriage does not appear to be a risk factor and reservoir in patients with acute folliculitis.

Keywords: Folliculitis; *Staphylococcus aureus*; culture; nasal cavity

ÖZET Amaç: *Staphylococcus aureus n*azal taşıyıcılığının prevalansı ve insidansı, çalışma yapılan toplumlara ve gruplara göre değişkenlik göstermektedir. Stafilokok kaynaklı deri enfeksiyonlarının tekrarlaması ile nazal taşıyıcılık arasında bir bağlantı olduğu bilinmektedir. Bu çalışmada, nüks öyküsü olmayan akut folikülit hastalarında *S. aureus* nazal taşıyıcılık prevalansı ile nazal kültürlerin mikrobiyolojik profilinin belirlenmesi ve sonuçların kontrol grubu ile karşılaştırılması amaçlanmıştır. Ayrıca demografik faktörlerin, bakteri üremesi üzerindeki etkilerinin değerlendirilmesi de amaçlar arasındadır. **Gereç ve Yöntemler:** Çalışma olgu kontrol araştırması olarak, ikinci basamak sağlık kuruluşunda yapıldı. Çalışmaya, dermatoloji polikliniğine Mayıs-Ağustos 2021 tarihleri arasında başvuran ve akut folikülit tanısı alan toplam 120 hasta dâhil edildi. Hastaların yaş, cinsiyet ve meslekleri, folikülit lokalizasyonu, ailede folikülit öyküsü, düzenli olarak berbere gitme öyküsü, ailede sağlık çalışanı olup olmadığı ile ilgili bilgiler kaydedildi. Hasta ve kontrol gruplarının nazal sürüntü kültürlerinin mikrobiyolojik verileri de ayrıca kayıt altına alındı. **Bulgular:** Hastaların nazal kültürlerinde %29,1 oranında bakteri üremesi bulundu. Metisiline duyarlı *S. aureus* hem hasta hem de kontrol gruplarında oransal olarak en sık izole edilen mikroorganizmaydı. Nazal sürüntü kültüründe mikrobiyolojik profil ve bakteri üremesi açısından hasta ve kontrol grupları arasında istatistiksel fark yoktu. **Sonuç:** Akut folikülit tanılı hastaların *S. aureus* nazal kolonizasyon sıklığı, sağlıklı popülasyonla benzer oranlardadır. Akut folikülit hastalarında *S. aureus* nazal taşıyıcılık, bir risk faktörü ve rezervuar olarak görülmemektedir.

Anahtar Kelimeler: Folikülit; *Staphylococcus aureus*; kültür; nazal kavite

Staphylococcus aureus are world-wide pathogens and can be cultured from various body sites such as the skin, vagina, rectum, gastrointestinal tract, and axilla.[1,2] The main reservoir localization is the anterior nares (vestibulum nasi).[3,4] The presence of *S. aureus* in the nares depends on host factors and seems to induce both innate and adaptive immune systems. Once *S. aureus* can come through the mech-

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anisms of host defense, it can increase in numbers into the anterior nares. In this way, the host becomes a nasal carrier with *S. aureus*.[3,5]

S. aureus carriage rates increased significantly in subgroups of patients with diabetes mellitus, hemodialysis, those on continuous ambulatory peritoneal dialysis, human immunodeficiency virus (HIV) infection or acquired immune deficiency syndrome, intravenous drug addiction, postoperative wound infections, and atopic dermatitis.[3,4,6-9] *S. aureus* nasal carriage was identified to be a main risk factor and a reservoir for patients with skin and soft tissue infections, community acquired, or nosocomial staphylococcal skin infections, and recurrent furunculosis.[3-6,10,11]

Furunculosis and folliculitis are common types of skin and soft tissue infections and can periodically recur.[6] The furunculosis generally caused by *S. aureus* is a deep infection of the hair follicle leading to abscess formation. The folliculitis is an inflammatory reaction in the superficial part of the hair follicle involving the perifollicular hair follicles or follicular opening.[12] Although any hair-bearing region may be affected in folliculitis, it occurs most frequently in the moist areas of the body and in areas prone to friction and perspiration.[12,13] While the inflammation manifests as 1 mm-wide vesicles, pustules, or papulopustules in acute cases clinically, the chronic course involves keratotic plug formations and hyperkeratosis.[12] Folliculitis is caused by infection, chemical irritation, and physical damage. Infectious folliculitis are originated from bacteria or non-bacterial causes such as viral, fungal, and parasitic. *S. aureus* is the main common cause of acute form of bacterial folliculitis.[12,14]

The prevalence and incidence of *S. aureus* nasal carriage differ in terms of the population studied.[4] It is known that there is a link between recurrence of staphylococcal skin infections and nasal carriage. The study aimed to determine the prevelance of the *S. aureus* nasal carriage and microbiological profile of the nasal cultures in patients with acute folliculitis without a history of recurrence, to compare the results with the control group, and to evaluate the demographic factors on bacterial growth.

MATERIAL AND METHODS

This was a prospective case series involving a sample of patients with acute folliculitis without a history of recurrence. The study was conducted in a secondary state hospital between May and August 2021. The study was approved by the Health Science University Dr. Abdurrahman Yurtaslan Oncology Training and Research Center Ethics Committee with ethical approval number: 2021-05/1134 and ethical approval date: May 26, 2021, and carried out compatible with the Declaration of Helsinki principles. Written informed consent forms were obtained from all participants before the study.

A total of 120 patients diagnosed with acute folliculitis who visited dermatology outpatient clinic were enrolled in the study. Patients between 18-65 years old were randomly selected and were examined by the same dermatologist. Patients' demographics including age, gender, job, having a family history of folliculitis, history of visiting a barber regularly, having a health care worker in the family, and localization sites of folliculitis were recorded. The localization sites were determined as scalp, beard, trunk, and extremity. In scalp localizations, patients who have scarring alopecia which is a feature of chronic process and recurrence were excluded.

A total of 89 participants between 18-65 years old who visited dermatology outpatient clinic diagnosed with tinea pedis hyperkeratotic type were randomly selected as the control group. Inclusion criteria were being volunteered to participate in the study and not having any additional dermatological disease.

Participants with diabetes mellitus, cancer, HIV, acne vulgaris, pseudofolliculitis, previous history hospitalization or surgery and using systemic isotretinoin drugs, immunosuppressive or antibiotic treatment, or topical nasal drugs were excluded both from the patient and control group.

The nasal culture was taken with sterile swabs from the anterior nares of patients. The specimens were transported to the microbiology laboratory with standardized methods. The swab was immediately inoculated on blood agar and incubated at 37 °C for 48

h. *S. aureus* isolates were identified by catalase and coagulase testing of colonies with typical morphology. Isolation of *S. aureus* from the nares was considered colonization. Patients' and control groups' microbiological data from nasal swab cultures were recorded.

The antibiotic susceptibility tests for S. *aureus* isolates were studied under recommendations of the European Committee on Antimicrobial Susceptibility Testing using Mueller Hinton agar medium with the Kirby-Bauer disc diffusion method.[15]

Statistical analyses were conducted using IBM SPSS for Windows (IBM Corp., version 22.0, Armonk, NY, USA). In describing the basic features of the data, the number of cases and proportions were given for categorical data, and median (range) was calculated for non-normally continuous data. Kolmogorov-Smirnov test was used to test for the normality of continuous data. The difference in age between the control and patient groups was compared by the Mann-Whitney U test. Whether there is a difference between control and patient groups according to the categorical variables was analyzed by the Pearson chi-square test. Binary logistic regression analysis was employed to model the relationship between bacterial growth (present/absence) and independent variables such as age, sex, job, having a family history of folliculitis, history of visiting a barber regularly, having a health care worker in the family. Each risk factor according to bacterial growth was also evaluated by odds ratios. The binomial test was also used as a non-parametric test for comparing control and patient groups in the presence of methicillin-sensitive *S. aureus* (MSSA) and methicillin-resistant *S. aureus* (MRSA). A p value <0.05 for two-sided tests was considered statistically significant.

RESULTS

A total of 120 patients and 89 controls were included in the study. Twenty-eight (23.3%) of the patients were females and 92 (76.7%) were males with a median (range) age of 31.5 (47) years, (minimum-maximum age 18-65). Twenty-eight (31.5%) of the controls were females and 61 (68.5%) were males with a median (range) age of 34 (41) years (minimum-maximum age 18-59). There was no statistically significant difference between the groups of patient and control in terms of age and gender (p>0.05).

The microbiological profiles and bacterial growth in nasal swab culture of two groups were analyzed. MSSA was the most commonly isolated microorganism both in patient and control groups not statistically, but as a ratio. There was no statistically significant difference between patients and controls in terms of microbiological profiles and bacterial growth in nasal swab culture (Table 1).

No significant association was found between microbiologic profiles in nasal culture and age, gender, job, having a family history of folliculitis, history of visiting a barber regularly, presence of a health care worker in the family in patients with folliculitis. There was a statistically significant association between trunk localization and MSSA (p=0.029). The demographic, clinical, bacterial growth, and microbiological characteristics of patients were shown in Table 2.

DISCUSSION

About 30% of the world's population is asymptomatically colonized with nasal *S. aureus* and, it was thought to be permanent.[3] In the current study, there was bacterial growth in 29.1% of the patients' nasal cultures. The nasal colonization frequency of the con-

TABLE 1: Microbiological profiles and bacterial growth in nasal swab culture.

	Patients n=120	Control n=89	p value
Bacterial growth			
Yes	35 (29.1)	22 (24.7)	0.475
No	85 (70.9)	67 (75.3)	
Microbiological profile			
MSSA	26 (21.6)	14 (15.7)	†
MRSA	2 (1.7)	8 (9.0)	
S. epidermidis	2 (1.7)	0 (0.0)	
S. intermedius	1 (0.8)	0 (0.0)	
Staphylococcus spp.	3 (2.5)	0 (0.0)	
Other CNS	1 (0.8)	0 (0.0)	

Frequencies are given as percentages in parentheses; †Chi-square assumptions are not met; MSSA: Methicillin-sensitive *Staphylococcus* aureus; MRSA: Methicillin-resistant *Staphylococcus* aureus; *S. epidermidis*: *Staphylococcus epidermidis*; *S. intermedius: Staphylococcus intermedius*; CNS: Coagulase-negative *Staphylococci*.

TABLE 2: Demographic, clinical, and bacterial growth characteristics of patients (n=120).

		Bacterial growth	MSSA	MRSA			
	Patients n (%)	Yes	No	Yes	No	Yes	No
Jobs							
Housewife/retired	22 (18.3)	7 (31.8)	15 (68.2)	5 (22.7)	17 (77.3)	0 (0.0)	22 (100.0)
Employee	69 (57.5)	20 (29.0)	49 (71.0)	15 (21.7)	54 (78.3)	1 (1.4)	68 (98.6)
Student	15 (12.5)	2 (13.3)	13 (86.7)	1 (6.7)	14 (93.3)	0 (0.0)	15 (100.0)
Health care professional	6 (5.0)	2 (33.3)	4 (66.7)	2 (33.3)	4 (66.7)	0 (0.0)	6 (100.0)
Police/soldier	6 (5.0)	3 (50.0)	3 (50.0)	2 (33.3)	4 (66.7)	1 (16.7)	5 (83.3)
Barber	2 (1.7)	1 (50.0)	1 (50.0)	1 (50.0)	1 (50.0)	0 (0.0)	2 (100.0)
p value		†		†		†	
Having a family history of folliculitis							
Yes	10 (8.3)	3 (30.0)	7 (70.0)	3 (30.0)	7 (70.0)	0 (0.0)	10 (100.0)
No	110 (91.7)	32 (29.1)	78 (70.9)	23 (20.9)	87 (79.1)	2 (1.8)	108 (98.2)
p value	1.000‡	0.450‡	1.000‡				
Having a health care worker in the family							
Yes	8 (6.7)	0 (0.0)	8 (100.0)	0 (0.0)	8 (100.0)	0 (0.0)	8 (100.0)
No	112 (93.3)	35 (31.3)	77 (68.7)	26 (23.2)	86 (76.8)	2 (1.8)	110 (98.2)
p value	0.103‡	0.199‡	1.000‡				
Barber visiting regularly							
Yes	105 (87.5)	29 (27.6)	76 (72.4)	20 (19.0)	85 (81.0)	2 (1.9)	103 (98.1)
No	15 (12.5)	6 (40.0)	9 (60.0)	6 (40.0)	9 (60.0)	0 (0.0)	15 (100.0)
p value	0.494§	0.132§	1.000‡				
Localization of lesions							
Scalp	106 (88.3)	29 (27.4)	77 (72.6)	21 (19.8)	85 (80.2)	1 (0.9)	105 (99.1)
p value	0.375§	0.298§	0.221‡				
Beard	34 (28.3)	14 (41.2)	20 (58.8)	10 (29.4)	24 (70.6)	1 (2.9)	33 (97.1)
p value	0.110§	0.195§		0.488‡			
Trunk	16 (13.3)	7 (43.8)	9 (56.2)	7 (43.8)	9 (56.2)	0 (0.0)	16 (100.0)
p value	0.279§	0.029§		1.000‡			
Extremity	10 (8.3)	2 (20.0)	8 (80.0)	2 (20.0)	8 (80.0)	0 (0.0)	10 (100.0)
p value	0.722‡	1.000‡		1.000‡			

†Chi-square assumptions are not met; ‡Fisher chi-square test; §Pearson chi-square test; MSSA: Methicillin-sensitive Staphylococcus aureus; MRSA: Methicillin-resistant *Staphylococcus aureus*.

trol group was 24.2% and lower than patients with folliculitis, however, there was not any statistically significant difference between groups. The current study shows that the nasal carriage frequency in patients with acute folliculitis is similar to the healthy population as shown in the previous studies. This result may be linked to exclusion criteria. In this study, all the risk factors that may be related to *S. aureus* nasal carriage such as diabetes mellitus, cancer, HIV, acne vulgaris, pseudofolliculitis, and using systemic isotretinoin drugs were excluded.

S. aureus needs to set strong interactions with nasal epithelial cells and overcome host defense systems for successful nasal colonization.[3,16] *S. aureus* nasal colonization is a major risk factor for the development of staphylococcal infections and, this situation increases the risk of staphylococcal infections from 2 to 10 times.[3] *S. aureus* nasal colonization has also been claimed to play a crucial role for recurrent furunculosis, nasal colonization being present in about 60% of individuals with furuncles and impetigo.[11,17]

Durupt et al. studied 121 patients with community-acquired impetigo and furuncles. Nasal carriage of *S. aureus* was found in 37 of 64 (58%) patients with culture-confirmed *S. aureus* skin infection and there was a significant nasal carriage rate difference between patients with a simple furuncle (29%) and patients with chronic furunculosis (88%).[17] In the current study, all patients with folliculitis who had acute process had similar rates of nasal colonization with healthy population and patients with simple furuncle as reported by Durupt's et al. As chronicity of skin infection increases, the rate of *S. aureus* nasal colonization increases.[17,18]

In this study, MSSA was found to be the most cultured bacteria from both patients with folliculitis and the control group not statistically, but as a ratio. Moon et al. also reported MSSA was the most frequently isolated microorganism from the patient's nasal swabs before septorhinoplasty.[19] Studies with patients using systemic isotretinoin observed that MSSA is the most common isolated bacteria from nasal swabs.[20,21] Those studies also consisted of patients without systemic diseases as this study. MRSA can colonize as a normal flora element especially in the nasal flora and overall the rates of MRSA carriage in the public are still low but appear to be increasing swiftly.[4] MRSA was isolated at a rate of 1.7% in the patients and 9% in the control group. Salgado et al. reported the MRSA carriage rate as 0.2-7.4%, with an average of 1.3% in a meta-analysis study.[22] In another study with hotel staff, *S. aureus* carriage rates 10.2% (73 of the 715 participants) among them, and only 3 (0.4%) of the isolated strains were resistant to methicillin.[23] The difference between MRSA and MSSA is resistance to all penicillins and other b-lactam antibacterial drugs which limits the therapeutic options.[4,24] MRSA was once limited exceedingly to hospitals, some health care institutions, and patients frequently visiting these facilities. Since the mid-1990s, the number of MRSA infections has been increased excessively in the reported for communities without risk factors for exposure to the health care system. This increase has been related with the recognition of new MRSA strains called community-associated MRSA (CA-MRSA).[24] It manifests mainly in the skin and soft tissues.[11] In a study, CA-MRSA nasal carriage and frequency were investigated in 38 patients with pyoderma including folliculitis (n=18). Two (5.3%) CA-MRSA were isolated from patients with folliculitis, one from a lesion and one from a nasal swab. Only one (1%) CA-MRSA strain was isolated from the nasal swabs of the control group and no statistically significant difference was found between the two groups in terms of CA-MRSA frequency.[25] Similarly, there was not any significant difference between MSSA and MRSA strain rates among patients with folliculitis and healthy population in the current study. The general MRSA carrier rates in the population appear to be increasing in the world.[5] Although there was not a major difference, MRSA strains of healthy population's nasal swabs are more than patients in our study. So rising rates of nasal MRSA carriage in the community may explain the higher rates of nasal MRSA carriage in our control group.

The hands are the primary transmitters for *S. aureus* from surfaces to the nasal area.[3,5] Therefore, people in the same home or office are at risk of having infections via nasal carriage.[5] Bogaert et al. reported that being in a large household member was a risk for *S. aureus* nasal carriage.[26] In this study, a small percentage of patients (8.3%) had a family history of folliculitis however, the most common profession was employees which work in a populous environment. Milletli Sezgin et al. reported 39 (21.4%) of 183 medical students had *S. aureus* proliferation identified from nasal swab samples.[27] al Bustan et al. studied nasal carriage of 500 people working in restaurants and reported that 26.6% of them were colonized with *S. aureus*, similar rates with our study results.[28] Nasal carriage rates of *S. aureus* seem to be higher for professions that work in a community and may increase the incidence of folliculitis. However, the profession was not found significantly associated with nasal *S. aureus* colonization in patients with folliculitis in our study. Some studies found no difference in profession similarly, on *S. aureus* carriage.[29,30]

Another possible risk factor for folliculitis seems to visit barber regularly with a high proportion of 87.5% however, there was not a significant relationship between visiting barbershops and *S. aureus* carriage rates. The most common site where folliculitis

is seen was hair, but only a statistically significant association was shown between trunk localization and MSSA. In the literature, there is no data about visiting barbershops and folliculitis relationship. Previous studies mentioned barber education about pseudofolliculitis barbae and acne keloidalis nuchae.[31] To prevent developing folliculitis, barbers may be informed for diagnosis of folliculitis and disinfection of hair clippers.

Most of the studies on the risks of contracting *S. aureus* infections are related to skin and soft tissue infections. Eighty percent (range 42-100%) of patients with skin lesions were *S. aureus* nasal carriers, and 65% (range 29-88%) had the same types of phage in the skin lesion and nose.[5] However, only nares colonization were evaluated and culture of lesions to determine the etiology were not collected in this study.

Additionally, only one nasal swab culture was performed from patients, so it was not possible to classify patients as persistent or intermittent carriers. Longitudinal studies defined three different patterns of *S. aureus* carriage: persistent carriage, transient carriage, and non-carriage.[32] These categories were defined due to the number and percentage of swabs that were positive for *S. aureus* at different sampling times and the length of time that a carrier was colonized.[33] The more *S. aureus* loads and a higher risk of getting a *S. aureus* infection are found in the persistent carriers.[5] Chronic processes may be related to the persistent nasal carriage and acute folliculitis with positive nasal culture may be related to predisposing recurrence. Besides these mentioned, patients were diagnosed due to the anamnesis and physical examination as acute folliculitis. Only suspicious cases were examined microbiologically for differential diagnosis of folliculitis. These were the limitations of the current study.

CONCLUSION

The present study demonstrated that nasal colonization of patients with acute folliculitis has similar rates with the healthy population. To our knowledge, there is no data on the *S. aureus* nasal carriage in acute folliculitis. Although *S. aureus* nasal carriage appears to be an important risk factor and reservoir for staphylococcal skin infections, it does not seem to be a risk factor and reservoir in patients with acute folliculitis. Therefore, further studies with repeated nasal swab cultures for patients with folliculitis and comparative studies between acute and chronic folliculitis are needed.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Burcu Tuğrul, Funda Kemeriz;* ***Design:*** *Burcu Tuğrul, Hatice Gamze Demirdağ;* ***Control/Supervision:*** *Burcu Tuğrul;* ***Data Collection and/or Processing:*** *Burcu Tuğrul, Hatice Gamze Demirdağ, Funda Kemeriz, Melike Bahçecitapar;* ***Analysis and/or Interpretation:*** *Burcu Tuğrul, Hatice Gamze Demirdağ, Melike Bahçecitapar;* ***Literature Review:*** *Burcu Tuğrul, Hatice Gamze Demirdağ, Funda Kemeriz;* ***Writing the Article:*** *Burcu Tuğrul, Hatice Gamze Demirdağ, Funda Kemeriz, Melike Bahçecitapar;* ***Critical Review:*** *Burcu Tuğrul, Hatice Gamze Demirdağ, Funda Kemeriz;* ***References and Fundings:*** *Burcu Tuğrul;* ***Materials:*** *Burcu Tuğrul.*

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