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Original Article* / *Çalışma - Araştırma

The effects of regular hot black tea consumption on nasal carriage of methicillin-resistant *Staphylococcus aureus*

Sıcak siyah çay tüketiminin metisilin dirençli *Staphylooccus aureus* burun taşıyıcılığı üzerindeki etkileri

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Objectives: This study aims to evaluate the possible relationship between oral consumption of hot black tea and methicillin-resistant *Staphylococcus aureus* (MRSA) nasal carriage in a mid-sized town population in central Anatolia.

Patients and Methods: Nasal swabs were taken from a total of 109 subjects (53 females, 56 males; mean age 34.4 years; range 18 to 65 years) including 55 non-tea drinkers and 54 subjects consuming more than 10 cups of tea a day. The MRSA positivity in the nasal cultures was investigated.

Results: In the tea consumer group MRSA was cultured in 10 subjects. Twenty-one subjects' nasal cultures were positive for MRSA in the non-tea drinkers. We found a statistically significant difference in the nasal MRSA carriage among tea drinkers and non-tea drinkers.

Conclusion: Our study findings indicate a lower incidence of nasal MRSA carriage in tea drinkers, suggesting that certain soluble tea compounds may exhibit some antibacterial properties when consumed orally.

Key Words: Nasal carriage; *Staphylococcus aureus*; tea.

Amaç: Bu çalışmada İç Anadolu'da orta ölçekli bir yerleşim yeri nüfusunda oral sıcak siyah çay tüketimi ve metisilin dirençli *Staphyloccus aureus* (MRSA) burun taşıyıcılığı arasındaki olası ilişki değerlendirildi.

Hastalar ve Yöntemler: Elli beşi hiç çay içmeyen ve 54'ü günde 10 fincandan fazla çay tüketen toplam 109 bireyden (53 kadın, 56 erkek; ort. yaş 34.4 yıl; dağılım 18-65 yıl) burun sürüntüsü alındı. Burun kültürlerinde MRSA pozitifliği araştırıldı.

Bulgular: Çay içen grupta MRSA 10 bireyde kültürlendi. Çay içmeyenlerin 21'inin burun kültüründe MRSA pozitifliği saptandı. Çay içenler ve içmeyenler arasında MRSA burun taşıyıcılığı açısından istatistiksel olarak anlamlı bir fark bulundu.

Sonuç: Çalışma bulgularımız, çay içenlerde MRSA burun taşıyıcılığı insidansının daha düşük olduğunu ve bazı çözünür çay bileşiklerinin oral olarak tüketildiğinde birtakım antibakteriyel özellikler sergileyebileceğini göstermektedir.

Anahtar Sözcükler: Burun taşıyıcılığı; *Staphylococcus aureus*; çay.

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Staphylococcus aureus (S. aureus) infections constitute a major health care problem due to its high pathogenity and well known tendency to develop resistance to many antibiotics commonly used in daily practice.[1] Nasal carriage of *S. aureus* appears to play a key role in the epidemiology and pathogenesis of infection.[1-3] Moreover, the nasal carriage of methicillin-resistant *Staphylococcus aureus* (MRSA) is recognized as a risk factor for the acquisition of an endogenous infection and plays an important role in the spread of this pathogen not only in hospital care units but in the community as well.[3] Methicillin, the first semi-synthetic penicillin derivative resistant to hydrolysis by staphylococcal β-lactamase, was introduced into clinical use for the treatment of infections caused by penicillin-resistant *S. aureus* in 1960.[1]

Relevant studies have suggested that nasal carriage of MRSA may significantly increase the risk of a MRSA infection, although this finding has not been accepted widely.[4,5] In an effort to both prevent and treat MRSA, researchers have examined the antimicrobial effects of several commonly consumed plants and plant extracts.[6-8] Black tea extracted with eight different solvents, includes polyphenol contents which exhibit antibacterial and antioxidant activity against several types of pathogenic bacteria, including *Vibrio cholerae, Escherichia coli, Shigella, Salmonella*, and *S. aureus*.[9-11] Both *in vivo* and *in vitro* studies have demonstrated that tea or tea-based extracts have antimicrobial properties when applied topically.[12,13] But it is not clear whether or not tea exhibits the same antimicrobial activity when consumed orally as beverage.

The purpose of this study was to evaluate the relationship between oral consumption of tea and MRSA nasal carriage in a mid-sized town population in central Anatolia.

PATIENTS AND METHODS

Between October 2011 and August 2012, 1,023 patients were screened according to variables including age, daily black tea consumption habits in the last 12 months, history of recent hospitalization, recent antibiotic use and general health status. The subjects who drink less than 10 cups of tea or had allergies, acute infections, bronchial asthma, cardiopulmonary disease, kidney disease, autoimmune disorders, liver dysfunction, bleeding tendencies, vasomotor rhinitis, nasal polyposis or allergic rhinitis; were aged under 18 or over 65 years, had recent operations, systemic disorders, were smokers, alcohol or drug users were excluded from the study. With the above-mentioned criteria a total of 109 subjects (53 females, 56 males; mean age 34.4 years; range 18 to 65 years) were enrolled in this study. Based on the given responses the two groups were identified as non-drinkers (n=55) and those drinking 10 or more cups of hot black tea a day (n=54). A total of 109 anterior nasal cultures were taken by using sterilized dry electrostatic cloths (Swiffer™) and clean technique (non-sterile nitrile gloves from a newly opened box). Patients with the relationship between MRSA carriage and daily black tea consumption were evaluated. Local ethical committee approval was obtained before the study. (Bozok University Ethical Committee 19.01.2012-6/1).

Nasal specimens were collected and inoculated on plates with 5% sheep blood agar (SBA). The SBA plates were incubated at 37 °C for 24 hours. After 24-hours at 37 °C incubation of the SBA, the colonies which were cream to yellow and 1 to 2 mm in diameter were taken further investigation. Gram stain, tube coagulase test (Bactident coagulase, Merck, Germany) and catalase test were performed to define *S. aureus*. Colonies on the SBA which were gram positive cocci arranged in clusters were subjected to catalase and tube coagulase tests to identify *S. aureus*. Catalase and tube coagulase positive colonies were defined as *S. aureus* and investigated in terms of methicillin sensitivity.

Staphylococcus aureus isolates were screened for methicillin resistance by the disk diffusion method. For this, appropriate bacteria suspension (0.5 McFarland) was prepared from *S. aureus* colonies grown on the SBA and swabbed over the Mueller-Hinton agar. Then disk impregnated with 1-*μ*g oxacillin were placed onto Mueller-Hinton agar. After 24-hour incubation at 37 °C, zone diameters were measured and recorded.

Obtained results were evaluated according to Clinical Laboratory Standard Institute (CLSI) 2012, as sensitive (≥13 mm), intermediate (11-12 mm), or resistant (≤10 mm).

In this study, *S. aureus* isolates with 10 mm or less in diameter zone were considered MRSA while isolates with 13 mm or more in diameter were considered methicillin sensitive *Staphylococcus aureus* (MSSA).

Statistical analysis

We performed chi-square analysis. Statistical level of $p<0.05$ was considered significant for all analyses.

RESULTS

Nasal cultures were taken from 109 patients meeting the criteria. The study population included 109 subjects chosen according to the variables mentioned in the previous section. Methicillin-resistant *Staphylococcus aureus* was determined in 10 (18.5%) of 54 subjects in the tea-consuming group. In the non-drinker group MRSA was positive in 21 (67.7%) of 55 subjects. The difference between the two groups was statistically significant by chi-square test ($p=0.033$) (Table 1).

DISCUSSION

Staphylococcus aureus is a highly pathogenic, gram-positive, aerobic, toxin-producing, foodborne organism that can contaminate food and infect the skin, lung, heart, and other organs. Some strains of *S. aureus* that developed resistance to the beta lactam penicillins over time were called methycillin resistant *Staphylococcus aureus* or multidrug resistant *Staphylococcus aureus*.[1,5,6] While there is evolving evidence that the prevalence of MRSA is declining in some European countries, this pathogen still remains a significant public health problem throughout the world, especially in developing countries.[14] The prevalence of MRSA is high in the burns (57.7%) and dermatology (39.4%) wards,[15] The usual sites of MRSA colonization are areas of broken skin, the anterior nares, the groin and the axilla, with MRSA infections occurring most frequently in areas of broken skin and in the bloodstream. [4] Methycillin resistant *Staphylococcus aureus* nasal carriage is more common among people previously infected with *S. aureus*.[15] The average rate of nasal carriage of MRSA among health care personnel is acknowledged to be 5-12%, compared with 2% in the general US population, 2.5% in previously hospitalized persons, 7.5% in college students, and 6-35% in drug addicts.[5,16,17] Black tea is a quite popular natural beverage being consumed as hot or cold drinks throughout the world. A literature survey showed that tea infusions has been found to have antimicrobial activity against several types of pathogenic bacteria, including *Vibrio cholerae*, *Escherichia coli*, *Shigella*, *Salmonella*, and *S. aureus*.[18] Although the exact mechanism is still not fully understood, there is increasing evidence suggesting its antimicrobial properties.[18] The main substrates thought to be linked to the antimicrobial activity of tea are phenolic compounds, tannic acid and catechines.[13,19] Additionally the decrease of iron absorption due to tea consumption may be another potentiating factor because this element is critical for *S. aureus* growth.[20]

Yamada et al.,[13] randomized 24 elderly patients with cerebrovascular disease and MRSA-positive sputum and treated with tea catechin extracts or saline as control, each given by a nebulizer three times daily, for four weeks. After one week, seven of the 12 patients in the tea-treated group had a decrease in MRSA concentration in their sputum, compared with none of the saline control group. Perhaps even more impressive, the average length of hospitalization was 51 days in the tea-treated group vs. 85 days in the saline-treated group. There are some other studies concluding that tea extracts may have potent antibacterial effects *in vivo* and *in vitro* against a wide range of pathogenic bacteria, including antibiotic-resistant strains.[9-11,18,21] Black tea extract has been found to be more effective against gram-positive bacteria such as *S. aureus Haemophilus aphrophilus, Bacillus cereus*, e.g., then gram-negative bacteria. The reason for this is lipopolysaccharides in the outer membrane of gram negative bacteria prevent penetration.[22,23] As shown in some studies iced

Table 1. Distribution of methycillin-resistant *Staphylococcus aureus* between two study groups

	MRSA (-)		MRSA (+)		*Total*	
	n	%	n	%	n	%
No tea	34	61.8	21	38.2	55	100
10 cups tea/day	44	81.5	10	18.5	54	100

MRSA: Methycillin-resistant *Staphylococcus aureus*.

tea has lower levels than hot tea of polyphenolic compounds per unit volume, which may reflect that the compounds in tea are more soluble at higher temperatures.[24,25] In a study conducted by Fujii et al.,[12] bedridden patients with MRSA-infected decubitus ulcers were debrided with application of either green tea or normal saline for one month. At the end of the study the patients who were treated with green tea debridement experienced a marked decrease in ulcer severity, and MRSA had disappeared in one-half. In the patients treated with normal saline debridement, ulcer severity was unchanged, and all of the ulcers were still infected with MRSA. In this study, nasal cultures were taken from 109 patients meeting the criteria. Methycillin resistant *Staphylococcus aureus* was determined in 18.5% in tea consuming group. In the non-drinker group MRSA was positive in 67.7%. The difference between the two groups was statistically significant. In our literature survey we found an antibacterial effect of black tea. Our study results are similar to the literature but are the most detailed of the studies in the literature.

Our findings indicating a lower likelihood of MRSA nasal carriage among individuals who drink more than 10 cups a day of hot black tea suggest that hot black tea may have antibacterial properties when consumed orally or through volatile ingredients in the vapor reaching to nares.

Declaration of conflicting interests

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