ABCResearch

Arch Basic Clin Res 2023; 5(3): 350-354 • DOI: 10.5152/ABCR.2023.22126

Original Article

Antibiotic Resistance of *Staphylococcus aureus* Strains Isolated from Wound Specimens of Patients Admitted to the Orthopedics and Traumatology Department of a Tertiary Care Hospital

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Cite this article as: Gür V, Yapıcı F, Subaşı İÖ, et al. Antibiotic resistance of *Staphylococcus aureus* strains isolated from wound specimens of patients admitted to the orthopedics and traumatology department of a tertiary care hospital. *Arch Basic Clin Res.*, 2023;5(3):350-354.

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ABSTRACT

Objective: *Staphylococcus aureus* is a critical infectious agent in orthopedics and traumatology clinics. Treatment of *S. aureus* infection is a problem, mainly due to the increased incidence of methicillin-resistant strains. This study aims to determine the antibiotic resistance of *S. aureus* strains isolated from wound samples of patients admitted to a tertiary care hospital's orthopedics and traumatology clinic.

Methods: Patients admitted to our hospital's orthopedics and traumatology clinic between January 2012 and November 2018 were included in this study and studied retrospectively. Participants in the study were required to have *S. aureus* strains present within their wounds. In addition to more traditional approaches, an automated microbiologic agent detection system known as VITEK® 2 Compact (bioMérieux, Marcy l'Etoile, France) was utilized in this study to identify *S. aureus* and determine its level of antibiotic resistance.

Results: *S. aureus* was identified in 64 out of 298 wound samples, with a detection rate of 21.5%. Fifty-one *S. aureus* strains (79.7% of the total) were taken from the inpatient clinic, and the remaining 13 (20.3%) were obtained from the outpatient clinic. *S. aureus* strains were categorized as either methicillin-resistant *S. aureus* positive (19 patients, 29.7%) or methicillin-susceptible *S. aureus* positive (45 patients, 70.3%), with the majority being methicillin-susceptible *S. aureus* positive.

Conclusion: We found out that among methicillin-resistant *S. aureus* positive patients, vancomycin, teicoplanin, linezolid, tigecycline, and daptomycin were effective antibiotic agents for the treatment. Also, methicillin-resistant *S. aureus* positive patients were resistant to penicillin, rifampicin, tetracycline, and erythromycin. This study detected methicillin resistance as a significant issue, and *S. aureus* strains antibiotic resistance in our study population was comparable to previous research.

Keywords: Antibiotic resistance, orthopedics and traumatology, *Staphylococcus aureus*, wound infection

INTRODUCTION

In developing countries, infectious diseases represent a significant public health issue. A substantial component of contagious diseases is wound infections.[1] When bacteria colonize a wound, virulence factors may subvert the immune system. Then bacterial infections of the skin and subcutaneous tissue may occur.[2] As a result, the area

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Received: January 2, 2023
Accepted: February 13, 2023
Publication Date: April 3, 2023

around the wound develops infection-specific symptoms such as purulent discharge, discomfort, broad erythema, or cellulitis.[3]

Intensive care units and surgical clinics are typically where wound infections are reported. At the same time, they can also occur in other settings, depending on the locale, patient profile, physical circumstances, and antibiotic use rules. As a result, wound infections are commonly reported in orthopedic and traumatology clinics.[4]

The most common antibiotic-resistant bacterial agent identified in orthopedic and traumatology clinics is *Staphylococcus aureus*.[5] Antibiotic resistance of bacteria began with sulfonamides and penicillins.[6] Currently, *S. aureus* may also be resistant to glycopeptides. Significant issues are brought on mainly by the rise in methicillin-resistant *S. aureus* (MRSA) strains.[7,8] Treatment and management of infections caused by these germs are challenging due to the advent of methicillin resistance in *S. aureus* strains (SASs) and their resistance to several other medications.[9] Antibiotic resistance in SASs should therefore be identified.

This study aimed to identify the antibiotic resistance of SASs isolated from the wound samples of patients who applied to the orthopedic and traumatology clinic of a tertiary care hospital, as well as to introduce the treatment choices that may be used empirically.

METHODS

Ethics committee approval was received for this study from the ethics committee of Erzincan Binali Yıldırım University (Date: December 8, 2022, Number: 2022-7/04).

MAIN POINTS

- Patients admitted to the orthopedics and traumatology clinic at our tertiary care hospital had a detection rate for *Staphylococcus aureus* in wound samples of 21.5%.
- The methicillin-resistant *S. aureus* positive (MRSA+) rate among these *S. aureus* samples was 29.7%, while the methicillin-susceptible *S. aureus* positive (MSSA+) rate was 70.3%, with the vast majority of the samples being, luckily, MSSA+.
- Effective antibiotics for treating MRSA+ patients were vancomycin, teicoplanin, linezolid, tigecycline, and daptomycin.
- Patients with MRSA exhibited resistance to penicillin, rifampicin, tetracycline, and erythromycin.
- Methicillin resistance has emerged as a major health problem.

A retrospective analysis of patients who were admitted to the orthopedics and traumatology clinic at Erzincan Binali Yıldırım University Faculty of Medicine Hospital between January 2012 and November 2018 was performed for this study. The investigation comprised patients with wound samples of SASs. The microbiology department received wound samples stored in sterile transport containers to isolate *S. aureus*.

First, the samples were stained using the Gram method in the microbiology laboratory. Then they were analyzed to determine whether or not they included leukocytes, epithelial cells, and the most prevalent bacteria. After seeding the samples on "Eosin Methylene Blue" agar with 5% sheep blood agar, the plates were placed in an incubator at 37°C for 24 hours. Conventional techniques such as catalase and coagulase, in addition to Gram staining, were utilized to identify the cultivating bacteria. In addition to the more traditional approaches, an automated microbiology system known as the VITEK® 2 Compact from bioMérieux in Marcy l'Etoile, France, was employed to identify the strains and find out which antibiotics were effective against them.

The methicillin and other antibiotic resistance status of SASs obtained from wound samples were interpreted according to the criteria of the Clinical Laboratory Standards Institute between the years 2012 and 2016 and according to the criteria of the European Committee on Antimicrobial Susceptibility Testing between the years 2017 and 2018. Both sets of criteria were used in this study.[10,11]

RESULTS

There were a total of 298 wound samples, and *S. aureus* was detected in 64 of them (21.5%). The average age of patients who had *S. aureus* was 51.6 ± 5.2 years. Thirty-five of the strains were obtained from male patients, making up 54.7% of the total. Fifty-one of the SASs (79.7%) were taken from the inpatient ward of the orthopedic department, and 13 (20.3%) of the SASs were obtained from the outpatient clinic.

Methicillin-resistant *S. aureus* was found in 19 (29.7%) of the SASs, while methicillin-susceptible *S. aureus* (MSSA) was found in 45 (70.3%) of the strains. Fortunately, there were no SASs found to be resistant to vancomycin, teicoplanin, linezolid, tigecycline, or daptomycin when the antibiotic susceptibilities of these strains were tested. Methicillin-resistant *S. aureus* strains have had high rates of resistance among these 4 antibiotics: penicillin, rifampicin, tetracycline, and erythromycin, respectively. Table 1 presents the antibiotic resistance rates of SASs that were isolated during the course of the study.

Table 1. Antibiotic Resistance Rates of *Staphylococcus aureus* Strains Isolated in the Study

Antibiotics	No. (%) of resistant strains	
Vancomycin	0	(0)
Teicoplanin	0	(0)
Linezolid	0	(0)
Tigecycline	0	(0)
Daptomycin	0	(0)
SXT	1	(1.6)
Fusidic acid	6	(9.4)
Levofloxacin	7	(10.9)
Clindamycin	7	(10.9)
Ciprofloxacin	8	(12.5)
Gentamycin	9	(14.1)
Rifampicin	16	(25.0)
Tetracycline	17	(26.6)
Erythromycin	20	(31.3)
Penicillin	58	(90.1)

SXT: Trimethoprim/Sulphamethoxazole

DISCUSSION

Orthopedic infections are an important cause of morbidity and mortality.[1] Wound infections are the most common manifestation of orthopedic infections. They heal late, cause anxiety, and prolong the hospital stay, as well as impose a significant financial burden on the health system.[12]

Because the treatment of orthopedic infections requires the use of antibiotics for an extended period of time, the selection of the proper antibiotics is one of the most critical aspects of the treatment process.[13] However, rising antibiotic resistance is a significant issue that has to be addressed. *S. aureus* poses a significant risk to people's health all throughout the world, particularly because of the widespread prevalence of methicillin resistance. There have been numerous reports of MRSA strains that are resistant to macrolides, quinolones, tetracyclines, lincosamides, and aminoglycosides, most notably all beta-lactams.[14] Methicillin-resistant *S. aureus* ratios were reported as 41% in Belarus, 13% in Bosnia and Herzegovina, 34% in Montenegro, 23% in Russia, 27% in Serbia, 4% in Switzerland, 48% in Macedonia, and 22% in Türkiye according to the Central Asian and Eastern European Surveillance of Antimicrobial Resistance data published by the World Health Organization in 2017.[15] Rising rates of antibiotic resistance in bacterial populations are keeping this issue at the forefront of public health concerns not only in the United States but also internationally.[1] Gundem and Cıkman[16] and Dogan et al[17] reported rates of MRSA in SASs isolated from wound infections in our nation of 21.8% and 18.3%, respectively. In a different study, Altan et al[4] demonstrated that methicillin resistance varied between clinics and estimated this rate to be between 21% and 29%. The MRSA rate of 29.7% discovered by our study is comparable to studies conducted in our nation.

Methicillin-resistant *S. aureus* infections are presently treated with teicoplanin and vancomycin. Resistance is rarely documented despite their widespread usage in the treatment of *S. aureus* infections.[18] As of right now, vancomycin and teicoplanin resistance have not been found in any studies conducted in our nation. No SASs were discovered in our study that were resistant to teicoplanin and vancomycin.

In addition to glycopeptides, linezolid, tigecycline, and daptomycin are common antibiotics used to treat resistant staphylococcal infections. Linezolid, tigecycline, and daptomycin have been proven successful in numerous researches looking at resistance in SASs in our country.[17,19-21] On the other hand, daptomycin resistance was reported to be 0.4% by Tefera et al[22] and 2% by Yenişehirli et al.[23] Additionally, Tekin et al[24] discovered 1.7% linezolid resistance in MRSA strains isolated from bloodstream infections. Nazik et al[25] and Wang et al[26] found tigecycline resistance at 2.6%, and 4%, respectively. Nazik et al[25] found SASs resistant to linezolid, tigecycline, and daptomycin in a ratio of 1.6%. All of the SASs isolated from wound samples in our investigation were negative for tigecycline, daptomycin, and linezolid resistance.

Fusidic acid is quite cytotoxic to SASs in vitro. Treatment of mild to severe staphylococcal infections with fusidic acid is successful, particularly for MRSA strains.[14] Fusidic acid resistance was shown to occur at a rate of 6% in MRSA strains and 3% in MSSA strains by Silva et al.[14] Dogan et al[17] observed that all MRSA strains in their investigation were vulnerable to fusidic acid in a study that only investigated wound samples and discovered that 5% of MSSA strains have fusidic acid resistance. As a result, the statistics from our country are comparable to the fusidic acid resistance in our study.

In the course of our research, we collected and analyzed culture samples taken from wounds that had been caused by a variety of etiological factors. Some of the culture samples were collected from wounds that were caused by traumatic reasons, while others were taken from wounds that were caused by individuals who had a weakened immune system due to a condition such as diabetes mellitus. The fact that the patients whose specimens were cultured did not have the same immunological state

is one of the limitations of this investigation. We anticipate that in further trials with study groups consisting of patients who are comparable to one another in terms of etiological reasons and immunological response, it will be possible to acquire descriptive data that is more reliable.

S. aureus strains are an important factor isolated from wound samples in orthopedics and traumatology clinics. Inspite of the fact that the antibiotic resistance of these strains is comparable to that found in previous research, it has been noticed that methicillin resistance has emerged as a significant issue. In order to cut down on the number of wound infections that occur in hospitals, particularly within surgical units, we believe that the recommendations made by infection control committees should be implemented.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Erzincan Binali Yıldırım University (Date: December 8, 2022, Number: 2022-7/04).

Informed Consent: Informed consent was obtained from all individual participants included in the study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – V.G.; Design – F.Y.; Supervision – N.K.; Resources – İ.Ö.S.; Materials – M.B.G.; Data Collection and/or Processing – B.G.; Analysis and/or Interpretation – A.Ç.; Literature Search – F.K.; Writing Manuscript – V.G.; Critical Review – F.Y.

Declaration of Interests: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study has received no financial support.

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