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Vancomycin-Resistant *Staphylococcus aureus* Causing Ocular Infections in El-Gharbia Governorate, Egypt

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OCULAR infections caused by bacteria represent an important public health problem worldwide. This study was conducted to determine the antimicrobial resistance pattern and the emergence of cefoxitin- and vancomycin-resistant *S. aureus* causing ocular infections at El-Gharbia governorate hospitals. For this study, 300 *S. aureus* isolates were collected from patients suffering from eye infections from four hospitals in El-Gharbia governorate. Furthermore, isolates were molecularly characterized using 23s rRNA PCR. Antibiotic sensitivity tests were performed using the disk diffusion test. A total of 90 (31%) *S. aureus* isolates were identified, and distributed within the four hospitals as 25%, 33%, 48%, and 16% from Quotour hospital, El–Menshawy, El-Ramad and Quotour clinic, respectively. Moreover, *S. aureus* was isolated from male and female patients at the rate of 30.8 % and 31 %, respectively. *S. aureus* ocular isolates were sensitive to ciprofloxacin, levofloxacin, cefuroxime, amikacin, azithromycin, norfloxacin, sulbactam/ampicillin and cefotaxime. In contrast, 89%, 90%, 100% and 85% of these isolates showed resistance to ampicillin, cefoxitin, doxycycline hydrochloride, and vancomycin. Whereas, the rest of *S. aureus* strains were cefoxitin- and vancomycin-intermediate resistant. This study alerts the emergence of cefoxitin- and vancomycin-resistant *S. aureus* causing ocular infections among hospitals in the El-Gharbia governorate. Additionally, ciprofloxacin is the most effective antibiotic against *S. aureus* causing ocular infections reported in this study.

Keywords: Ophthalmic infections, Staphylococcus aureus, Vancomycin resistance, Methicillin resistance.

Introduction

The eye is always exposed to dust and microorganisms such as bacteria and fungi, which can cause significant eye damage. The eye's resistance to external influences via various mechanisms such as wetting by tears containing the bactericidal lysozyme, mucous membrane, and eyelid movement. This resistance may weaken in people suffering from certain diseases such as malignant tumors, organ transplantation, cortisol treatment for long periods, drug addicts, diabetics, and AIDS [1].

Bacteria that cause ocular infections include *staphylococcus aureus* (*S. aureus*), coagulase-negative staphylococci (CoNS), *Streptococcus pneumoniae,* and *Pseudomonas aeruginosa*.

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Followed by less frequent pathogens include *S. epidermidis*, *Bacillus subtilis, Bacillus cereus, Neisseria gonorrhea, Moraxella spp., Hemophilus influenza and Acinetobacter,* etc. [2]. *S. aureus* is one of the major human pathogens, causing infections ranging from minor skin and soft-tissue infections to life-threatening endocarditis, chronic osteomyelitis, pneumonia, or bacteremia, all associated with significant morbidity and mortality [3]. *S. aureus* is a common pathogen of the eye, capable of infecting external and internal tissues causing severe ocular infections such as keratitis, conjunctivitis, endophthalmitis and blepharitis. *S. aureus* produces numerous enzymes and toxins such as α-toxin, β-toxin, γ-toxin, Panton-Valentine leukocidin, and antibiotic resistance, which have an important role in increased tissue damage and failure of antibiotic therapy [2, 4].

Because of the organism's proclivity to develop antibiotic resistance, *S. aureus* has emerged as a major public-health threat [5]. Vancomycin is a glycopeptide antibiotic used to treat Gram-positive bacterial infections via inhibiting cell wall biosynthesis. Vancomycin is widely considered the gold standard for treating methicillin-resistant *S. aureus* (MRSA) keratitis. Resistance of MRSA strains to vancomycin has been described in the clinical literature worldwide, and it poses a significant threat in the therapeutic fields [3]. Therefore, The present study aimed to characterize *S. aureus* isolated from the human ocular infections at El-Gharbia governorate hospitals using phenotypic and molecular methods. In addition, the study was conducted to determine the antimicrobial resistance pattern and the emergence of cefoxitin- and vancomycin-resistant *S. aureus* causing ocular infections.

Material and Methods

Patients and Samples collection

This study was done on 300 patients with clinical diagnoses of ocular infections who visited the ophthalmic consultative clinic in 4 hospitals; Qutour hospital, El-Menshawy hospital, El-Ramad hospital and Qutour clinic (75 swabs were taken from each hospital) at El-Gharbia governorate, Egypt. The patients included both males and females from July 2017 to November 2020. Thirty (30) conjunctival swabs were taken from male patients at each hospital, with a total number of 120 samples, while 45 swabs were taken from female patients at each hospital with a total number of 180 samples. Each patient had undergone a conjunctival sampling by rolling a thin cotton swab over the lower fornix of the conjunctival sac. Eye swabs were inserted into the transport media and delivered to the bacteriology laboratory. This study was conducted with approval from the Medical Research Ethics Committee, Kafrelsheikh University. All participants gave their informed consent, and in the case of children, their parents gave their consent.

Phenotypic bacterial identification

Samples were transferred into 5ml of nutrient broth (Oxoid, UK) and incubated overnight at 37°C, then was inoculated on nutrient agar, blood agar, mannitol salted agar (Oxoid, UK). All plates were incubated for 24 hours at 37°C, and negative plates were incubated for an additional 24 hours. Phenotypic bacterial identification was done by culture characteristics, Gram stain and confirmed by biochemical tests: coagulase test, catalase test, oxidase test, urea hydrolysis, gelatin liquefaction test according to [6, 7]. The diagnosis was confirmed by using the Api20 Staph according to the manufacturer's protocol.

Molecular identification

A single pure colony of *S. aureus* was cultured overnight in Luria Bertani broth (HI-MEDIA®, Mumbai, India) at 37^{o}C for 24 hours. According to the manufacturer's protocol, the genomic DNA of *S. aureus* was extracted using QI amp DNA Mini Kit. The 25 µL PCR reaction volume consisted of 12.5 µL 2x Emerald Amp GT PCR mastermix (Takara, Japan, No. RR310A) was used to amplify the 23s rRNA gene using oligonucleotide primer sequences F (5'-AC GGAGTTACAAAGGACGAC-3') and R (5'-AGCTCAGCCTTAACGAGTAC- 3') (Metabion, Germany). The primers used in this study generated an amplicon of 1250 bp. The PCR reaction was conducted using a thermocycler (Biometra) with an annealing temperature of 55°C for 40 sec [8]. The amplicons were visualized using 2% agarose gel electrophoresis (Promega, Madison, USA).

Antimicrobial Susceptibility

Antibiotic sensitivity tests were determined using the disk diffusion method on a Muller-Hinton agar according to National Committee for Clinical Laboratory and Standards Institute CLSI [9]. The examined antimicrobials in this study were: ciprofloxacin (5 µg), levofloxacin (5 µg), cefuroxime (30 µg), cefoperazone/sulbactam (75/10 µg), amikacin (30 µg), azithromycin (15 µg), norfloxacin (10 µg), sulbactam/ampicillin (20 µg), cefotaxime (30 µg), cephardine (30 µg), oflaxacin (5 µg), amoxiclav (30 µg), erythromycin (15 µg), ampicillin (10 µg), cefoxitin (30 µg), doxycycline hydrochloride (30 µg), and vancomycin (30 µg).

Cefoxitin (30 µg) was used to test for oxacillin and MRSA resistance. Isolates with intermediate susceptibility to cefoxitin may have the *mecA* gene and were thus classified as cefoxitin resistant [10].

Results

Prevalence of S. Aureus From a total of 300 conjunctival swabs (75 swabs from each hospital) taken from infected ocular patients, all the tested patients were suffering from conjunctivitis, keratitis, and eye inflammation. The results indicated that 92 (31%) samples were *S. aureus* positive. It has been observed that 19 (25%), 25 (33%), 36 (48%) and 12 (16%) were identified from patients admitted to Qutour hospital, El-Menshawy hospital, El-Ramad hospital, and Qutour clinic, respectively (Table 1). All these samples were cultured on selective media and confirmed by biochemical tests. *S. aureus* isolates showed Gram-positive, non-spore-forming, non-motile, spherical cells, usually arranged in grape-like clusters. Colonies of *S.aureus* produced large yellow or white colonies on nutrient agar, while on blood agar, it produced yellow colonies surrounded by zones of clear β-hemolysis. Coagulase-positive staphylococci produce colonies surrounded by bright yellow zones on mannitol salt agar while non-pathogenic staphylococci produce colonies surround by reddish-purple zones.

Moreover, these isolates were confirmed through PCR for *S. aureus* using the 23s rRNA gene, which showed positive amplification of 23s rRNA genes at 1250 bp for all tested samples (Fig. 1).

The ocular infections caused by *S. aureus* strains in male and female patients were significantly similar. As shown in Table 1, 37 of 120 (30.8%) male patients, in comparison to 55 of 180 (30.6%) female patients from four hospitals, were *S. aureus* positive. Incidence of *S. aureus* among male patients was 7 (23%), 10 (33), 17 (56.7%), and 3 (10%) from Qutour hospital, El-Menshawy hospital, El-Ramad hospital and Qutour clinic, respectively. Furthermore, 12 (26.7%), 15 (33.3%), 19 (42%), and 9 (20%) from Qutour hospital, El-Menshawy hospital, El-Ramad hospital and Qutour clinic, were recorded respectively in El-Gharbia governorate (Table 1).

Prevalence of S. aureus according to age and sex

The overall percentage distribution of *S. aureus* from patients according to age showed diverse results. Twenty-five (25) conjunctival swabs were taken from each age at four hospitals. Most *S. aureus* infections (38%) were in adult patients over 45 years old. Meanwhile, it recorded (34%) in a child under 15 years old. On the other hand, the lowest incidence rate (20%) was recorded in adults aged between 15-45 years old (Table 2, 3). The overall percentage of *S. aureus* distributed among the four hospitals was 28%, 48%, 56%, and 20% of adult patients aged over 45 years from the four hospitals, respectively. Meanwhile, the isolation rate of *S. aureus* from child patients under 15 years old was 32%, 28%, 52% and 24%. On the other hand, the incidence rates were 16%, 24%, 36% and 24% from adult patients aged between 15-45 years old at Qutour hospital, El-Menshawy hospital, El-Ramad hospital and Qutour clinic, respectively (Tables 2, 3).

In comparison between age and sex, patients showed unique results were; 35 % of male adult patients aged over 45 years old were positive *S. aureus*, in contrast to 40% of female adult patients aged over 45 years old were positive *S. aureus*. Moreover, 17.5% of male patients compared to 23% female patients aged between 15-45 years old were positive for *S. aureus*. Furthermore, 40% of male child patients under 15 years were positive *S. aureus*, while 30% of female child patients under 15 years were positive *S. aureus* (Tables 2, 3).

Antibiotic susceptibility

The results of antibiotic susceptibility shown that *S. aureus* isolates were found to be susceptible to a variety of antibacterial agents (Table 4, Fig.2). *S. aureus* appeared to be sensitive to ciprofloxacin, levofloxacin, cefuroxime, amikacin, azithromycin, norfloxacin, sulbactam/ampicillin, and cefotaxime, with percentages of 99%, 98%, 95%, 93%, 90%, 85%, 80%, and 71%, respectively. At the same time, *S. aureus* showed intermediate sensitivity to cephradine, ofloxacin, amoxiclav, and erythromycin with percentages of 75%, 83%, 75%, and 70%, respectively. Furthermore, it was resistant to ampicillin, cefoxitin, doxycycline hydrochloride, and vancomycin with percentages of 89%, 90%, 100%, and 85%, respectively (Table 4).

Additionally, 10% and 15% of the isolates exhibited intermediate resistance to cefoxitin and vancomycin, respectively, and were classified as resistant to both drugs.

Discussion

Staphylococcus aureus is a significant pathogen in ocular infections. *S. aureus* was isolated from 31% of the patients examined in this study who had an eye infection. The study was carried out at four different hospitals. Qutour hospital had a 25% isolation rate, El-menshawy hospital had a 33% isolation rate, El-Ramad hospital had a 48% isolation rate, and Qutour clinic had a 16% isolation rate. The bacterial identification was confirmed using 23s rRNA gene PCR amplification.

Staphylococcus aureus (n= 11, 18.6%) was isolated from nasolacrimal duct infection in children with congenital nasolacrimal duct obstruction [11]. Whereas, 77.6% of *S. aureus* was isolated from patients admitted to Ibn-AL-Hythem hospital in Baghdad for an eye infection [1]. Furthermore, *S. aureus* was isolated from eye infections in pediatric patients enrolled at the "Luigi Vanvitelli" University Hospital of Campania in Naples, Italy, between 2017 and 2019 [12]. According to another study, the most common organism isolated from acute conjunctivitis for ten months studied in the Department of Ophthalmology at Nalanda Medical College and Hospital in Patna, Bihar, India, is coagulase-positive staphylococci [13]. A total of 21% *S. aureus* was isolated from 102 eye discharges in a retrospective study at Gondar University Hospital in Northwest Ethiopia from September 2009 to August 2012 [14].

In this study, samples were collected from both male and female patients; the percentage of male isolation was 30.8%, and the percentage of female isolation was 30.6%. In terms of age, it was discovered that the most susceptible patients to infection were those over 45 years old, with a percentage of 38%, followed by child patients under 15 years old, with a percentage of 34%. Patients between the ages of 15 and 45 were the least susceptible to infection, with a percentage of 20%. Similar to these findings, Petrillo et al. [15] discovered no significant differences between male (48.1%) and female (51.9%) *S. aureus* and coagulase-negative staphylococci (CoNS) isolates collected from patients with bacterial conjunctivitis and keratitis. However, the rate of staphylococci ocular infections was higher in the group of patients over 60 years old (66.8%), while the least infection cases were observed in the group under 31 years of age (8.0%). In another study, the majority of 100 cases of acute conjunctivitis was seen in the 25–35 age group. A male preponderance is noted with 65 males and 35 females [13].

In the present study, the results of the antimicrobial susceptibility testing showed that *S. aureus* resistance was observed most commonly to doxycycline hydrochloride exhibiting 100% isolates, followed by cefoxitin (90%), ampicillin (89%) and vancomycin (85%). At the same time, the rest of the isolates, 10% and 15%, were recorded as intermediate resistance to cefoxitin and vancomycin, respectively. Similar to these findings, isolates with intermediate susceptibility to cefoxitin may have the *mec*A gene and were thus classified as cefoxitin resistant. The cefoxitin disc diffusion method detected MRSA with greater sensitivity and specificity than other commonly used methods. Because it is simple to prepare, this method may be preferred in clinical microbiology laboratories [16]. Moreover, MRSA represented 30.7% (122 of 398) of the total *S. aureus* keratitis isolates. All *S. aureus* isolates were susceptible to vancomycin, while less susceptible to the fluoroquinolones than to the non-fluoroquinolones [10]. In their 10-year retrospective study at Chang Gung Memorial Hospital in Taiwan, Chuang et al. [4] discovered that MRSA accounts for 52.8% of ocular *S. aureus* infections per year, with nearly half of ocular MRSA infections being sight-threatening.

In contrast to these findings, among 21 cases of *S. aureus* infectious keratitis at Mansoura Ophthalmic Center, Egypt, there were 3 (14.3%) cases of methicillin-resistant *S. aureus* (MRSA), and all were vancomycin sensitive [17]. The antibiotic resistance patterns of 91 isolates of *S. aureus* from ocular tissues**.** The isolates were resistant to penicillin, streptomycin, tetracycline and framycetin with a percent of 97.8%, 66.6%, 69.2%, 69.2%, respectively, while they showed sensitivity to chloramphenicol, erythromycin, gentamycin and cloxacillin with a percentage of 70.4%, 63.8%, 63.8%, 100% respectively [18]. Furthermore, from 262 isolates of *S. aureus* causing ocular and otolaryngology infections found moderate to high rates of resistance to penicillin (78%), erythromycin (41%) and clindamycin (32%). The MRSA most affected antibiotics were erythromycin, levofloxacin and clindamycin. All MRSA and MSSA isolates were susceptible to daptomycin, linezolid and vancomycin [19]. The vancomycin is the most effective antibiotic for MRSA treatment [20]. Moreover, the resistance to ampicillin (76.9%), amoxicillin (53.8%), penicillin (69.2%), trimethoprim-sulphamethoxazole (69.2%), and tetracycline in 102 isolates of *S. aureus* isolated from eye discharges (61.6%) [14]. In contrast, the *S. aureus* isolates were sensitive to erythromycin (53.8%), gentamicin (53.8%), ceftriaxone (76.9%), ciprofloxacin (84.6%), and chloramphenicol (69.2%) [20]. According to Vola et al. [21], *S. aureus* isolates had higher rates of resistance to tobramycin, gentamicin, ciprofloxacin, gatifloxacin, and moxifloxacin. However, all isolates were susceptible to vancomycin.

The uncontrolled use of vancomycin led to an upsurge of vancomycin resistant S. aureus (VRSA) throughout the world. The rising incidence of MRSA has led to an overuse of vancomycin as a first-line glycopeptide, resulting in decreasing sensitivity to vancomycin and the emergence of VRSA strains. Therefore, VISA and VRSA have become more common in various regions of the world. It may also reflect changes through time due to the overuse of vancomycin for the treatment of infections caused by MRSA. Because of the increasing prevalence of MRSA, vancomycin has been overused as a first-line glycopeptide, resulting in an upsurge of vancomycin resistant *S. aureus* (VRSA) in many parts of the world [22]. Our findings revealed that 85% of the ocular isolates were VRSA, which is a higher rate than previously estimated in Egypt. This variation in VRSA prevalence may be geographically based, as well as reflecting changes over time due to the overuse of vancomycin for the treatment of ocular infections.

Conclusion

The total percentage of *S. aureus* isolation from El-Gharbia hospitals was 31%, with a similar percentage from the male (30.8%) and female (30.6%) patients. Accurate identification with 23s rRNA amplification is essential for precise therapy, tracking the spread of infections with epidemiologic characteristics, and studying disease progression. Furthermore, this study warns of the emergence of cefoxitin- and vancomycin-resistant *S. aureus* causing ocular infections in El-Gharbia governorate hospitals. Despite this, ciprofloxacin was found to be the most effective antibiotic against *S. aureus* causing ocular infections. Finally, in the treatment of bacterial keratitis, antimicrobial selection should be guided by annual regional surveillance, laboratory susceptibilities and clinical response. To further understand the mechanisms and genes behind this resistance, more research is required.

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Conflict of interest

None to report

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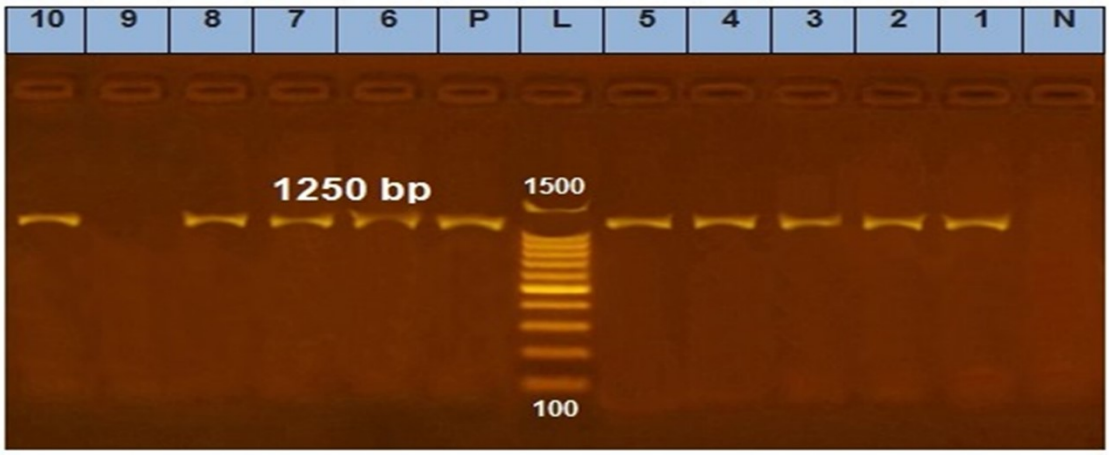

Fig. 1. Agarose gel electrophoresis of PCR for *S. aureus* 23s rRNA gene. Lane L: 100bp ladder as molecular size DNA marker. Lane p: control positive. Lane 9: negative control. Lanes 1,2,3,4,5,6,7,8,10: positive *S. aureus* 23s rRNA genes.

TABLE 1. Prevalence of *S. aureus* isolated from ocular infected male and female patients from different hospitals in El-Gharbia governorate.

Hospital	Total no. of samples	Positive samples		Male			Female		
				No of samples	Positive samples		No of samples	Positive samples	
		No.	%		No.	%		No.	%
Qutour Hospital	75	19	25	30	7	23	45	12	26.7
El-menshawy Hospital	75	25	33	30	10	33.3	45	15	33.3
El-Ramad Hospital	75	36	48	30	17	56.7	45	19	42.2
Qutour Clinic	75	12	16	30	3	10	45	9	20
Total	**300**	**92**	**31**	**120**	**37**	**30.8**	**180**	**55**	**30.6**

TABLE 2. Incidence of *S. aureus* positive samples among ocular infected male patients of different ages in El-Gharbia governorate hospitals.

Hospital	Total no. of samples	Male >45 years			Male 15-45 years			Male <15 years			Total	
		No. of samples	Positive samples		No. of samples	Positive samples		No. of samples	Positive samples			
			No.	%		No.	%		No.	%	No.	%
Qutour Hospital	30	10	2	20	10	1	10	10	4	40	7	23.3
El-menshawy Hospital	30	10	5	50	10	2	20	10	3	30	10	33.3
El-Ramad Hospital	30	10	6	60	10	4	40	10	7	70	17	56.7
Qutour Clinic	30	10	1	10	10	0	0	10	2	20	3	10
Total	**120**	**40**	**14**	**35**	**40**	**7**	**17.5**	**40**	**16**	**40**	**37**	**30.8**

TABLE 3. Incidence of *S. aureus* positive samples among ocular infected female patients of different ages in El-Gharbia governorate hospitals.

Hospital	Total no. of samples	Female >45 years			Female 15-45 years			Female <15 years			Total	
		No. of samples	Positive samples		No. of samples	Positive samples		No. of samples	Positive samples			
			No.	%		No.	%		No.	%	No.	%
Qutour Hospital	45	15	5	33.3	15	3	20	15	4	26.7	12	26.7
El-menshawy Hospital	45	15	7	46.7	15	4	26.7	15	4	26.7	15	33.3
El-Ramad Hospital	45	15	8	53.3	15	5	33.3	15	6	40	19	42.2
Qutour Clinic	45	15	4	26.7	15	1	7	15	4	26.7	9	20
Total	**180**	**60**	**24**	**40**	**60**	**13**	**21.7**	**60**	**18**	**30**	**55**	**30.6**

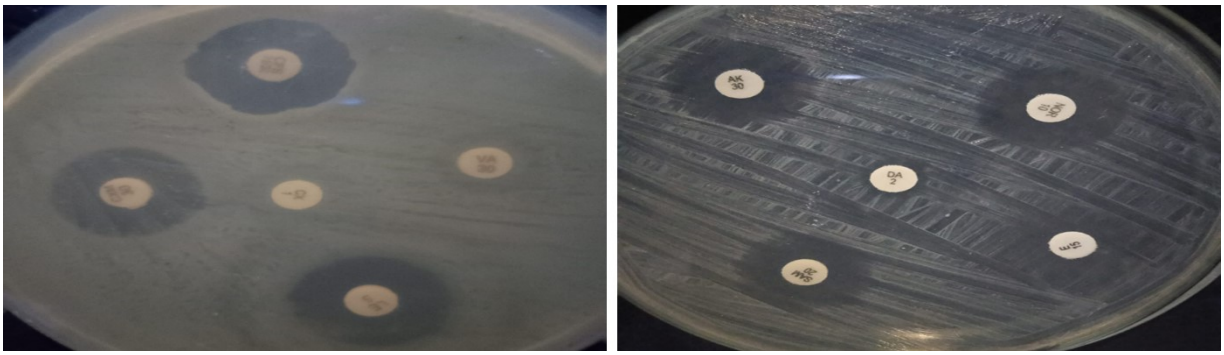

Fig. 2. Disk diffusion test for antibiotic susceptibility of *S. aureus* isolates causing ocular infection.

TABLE 4. Antibiotic susceptibility of 90 *S. aureus* causing ocular infections tested isolates.

Chemotherapeutic agent	Potency (µg)	No of tested isolates	S		I		R		Results
			NO	%	NO	%	NO	%	
Ciprofloxacin	5	90	89	99	1	1	0	0	S
Levofloxacin	5	90	88	98	2	2	0	0	S
Cefuroxime	30	90	85	95	5	5	0	0	S
Cefoperazone/Sulbactam	75/10	90	85	95	5	5	0	0	S
Amikacin	30	90	83	93	7	7	0	0	S
Azithromycin	15	90	81	90	9	10	0	0	S
Norfloxacin	10	90	77	85	13	15	0	0	S
Sulbactam/ Ampicillin	20	90	72	80	18	20	0	0	S
Cefotaxime	30	90	64	71	26	29	0	0	S
Cephardin	30	90	23	25	67	75	0	0	I
Oflaxacin	5	90	15	17	75	83	0	0	I
Amoxiclave	30	90	0	0	68	75	22	25	I
Erythromycin	15	90	0	0	63	70	27	30	I
Doxycycline hydrochloride	30	90	0	0	0	0	90	100	R
Ampicillin	10	90	0	0	10	11	80	89	R
Cefoxitin	30	90	0	0	9	10	81	90	R
Vancomycin	30	90	0	0	14	15	76	85	R

المكورات العنقودية الذهبية المقاومة للفانكومايسين المسببة لالتهابات العين في محافظة الغربية، مصر

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تمثل التهابات العين التي تسببها البكتيريا ومضاعفاتها مشكلة صحية عامة في جميع أنحاء العالم. وقد أجريت الدراسة لتحديد نمط مقاومة المضادات الحيوية وظهور المكورات العنقودية الذهبية (استافيلوكوكس أوريس) المقاومة للسيفوكسيتين والفانكومايسين المسببة لالتهابات العين بمستشفيات محافظة الغربية. تم فى هذه الدراسة تجميع 300 عينة من بكتريا S. aureus من مرضى يعانون من التهابات العين من أربعة مستشفيات بمحافظة الغربية، وتم توصيف العزلات جزيئيا باستخدام 23s rRNA PCR. وتم إجراء اختبارات حساسية المضادات الحيوية. أكدت النتائج تحديد 90 (31٪) عزلة من بكتريا S. aureus من المستشفيات الأربعة بنسبة 25٪ و 33٪ و 48٪ و 16٪ من مستشفيات قطور والمنشاوي والرمد وعيادات قطور على التوالي. علاوة على ذلك، كانت نسبة عزل المكورات العنقودية الذهبية من المرضى الذكور والإناث 30.8٪ و 31٪ على التوالي. وكانت كل عزلات *S. aureus* حساسة لأدوية السيبروفلوكساسين ، ليفوفلوكساسين ، سيفوروكسيم ، أميكاسين ، أزيثروميسين ، نورفلوكساسين ، سولباكتام / أمبيسيلين وسيفوتاكسيم. في المقابل ، أظهرت 89٪ ، 90٪ ، 100٪ و 85٪ من هذه العزلات مقاومة للأمبيسيلين ، سيفوكسيتين ، دوكسيسيكلين هيدروكلوريد ، وفانكومايسين. في حين أن سلالات المكورات العنقودية الذهبية الباقية كانت متوسطة المقاومة للسيفوكسيتين والفانكومايسين. وتنبه هذه الدراسة إلى ظهور المكورات العنقودية الذهبية المقاومة للسيفوكسيتين والفانكومايسين مسببة التهابات العين بين مستشفيات محافظة الغربية. بالإضافة إلى ذلك، يعد السيبروفلوكساسين هو المضاد الحيوي الأكثر فعالية ضد بكتريا المكورات العنقودية المسببة للعدوى العينية التي تم الإبلاغ عنها في هذه الدراسة.

الكلمات الدالة: الالتهابات العينية ، المكورات العنقودية الذهبية ، مقاومة الفانكومايسين ، مقاومة الميثيسيلين.