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Orthopedic Surgical Wound Infection: Microorganisms and Resistance Figures

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Abstract
Purpose: One of the most important and feared complications of modern orthopaedic surgery is postperative surgical wound infections. In this study, we aimed to investigate antimicrobial resistance rates of isolated microorganisms in wound infections after orthopaedic surgery.
Methods: Isolated bacteria were identified with conventional methods and automated system (Becton Dickinson Phoenix ID). Antimicrobial susceptibility of the strains were investigated according to Clinical Laboratory Standards Institute (CLSI) recommendations.
Results: Ninety six (37%) microorganisms were isolated from 257 wound specimens. These were: *Acinetobacter spp*. 24 (25%), *P. aeruginosa* 19 (20%), *S. aureus* 15 (16%), *E. coli* 10 (10%), *K. pneumoniae* 10 (10%), CNS 8 (8%), *P. mirabilis* 5 (5%), *Enterobacter spp*. 4 (4%), and Enterococcus spp. 1(1%), respectively. *Acinetobacter spp*. strains were resistant to imipenem by 92%, to amikacin by 83%, to ciprofloxacin by 89%, and to sulbactam-ampicillin (SAM) by 62%. 10% of *E. coli* and 40% of *K. pneumoniae* strains were extended to spektrulu beta-lactamase positive. 7% of *S. aureus*, 50% of CNS strains were methicillin resistant.
Conclusions: Considering local epidemiological data in the treatment of surgical wound infection is going to help increasing the chance of treatment success and reducing resistance rates by providing rational use of antibiotics.
Key Words: Antimicrobial Resistance; Microorganism; Orthopedic Surgical Wound İnfections.

Ortopedik Cerrahi Yara Enfeksiyonları: Mikroorganizmaların Direncine İlişkin Veriler

Özet
Amaç: Postoperatif dönemde modern ortopedik cerrahinin en önemli ve korkulan komplikasyonlarından biri cerrahi yara enfeksiyonlarıdır. Çalışmamızda ortopedik cerrahi sonrası bir yıllık sürede yara enfeksiyonlarından izole edilen mikroorganizmaların ve antimikrobiyallere direnç oranları araştırılmıştır.
Yöntem: İzole edilen mikroorganizmaların konvansiyonel yöntemler ve otomatize sistemle (Phoenix Becton Dickinson ID) tür tayini yapılmıştır. Elde edilen türlerin antimikrobiyal duyarlılık testleri Clinical Laboratory Standards Institute önerileri doğrultusunda çalışıldı.
Sonuçlar: İki yüz elli yedi yara örneğinden 96 (%37)'sında mikroorganizma izole edilmiştir. İzole edilen bakteriler sırasıyla *Acinetobacter spp.* 24 (%25), *P. aeruginosa* 19 (%20), *S. aureus* 15 (%16), *E. coli* 10 (%10), *K. pneumonia* 10 (%10), *Koagulaz negatif stafilokok (KNS)* 8 (%8), *P. mirabilis* 5 (%5), *Enterobacter spp*. 4 (%4) ve *Enterococcus spp*. 1 (%1) olarak belirlenmiştir. *Acinetobacter spp*. suşlarında imipeneme %92, amikasine %83, siprofloksasin %89 ve sulbaktam-ampisiline (SAM) %62 oranında direnç gözlenmiştir. *E.coli* suşlarında %10, *K.pneumonia* suşlarında ise %40 oranında GSBL (genişlemiş spektrumlu beta laktamaz) pozitifliği saptanmıştır. *S.aureus* suşlarının %7'si, KNS'lerin %50'si metisiline dirençli bulunmuştur.
Sonuç: Sonuç olarak; gelişen cerrahi yara enfeksiyonu tedavisinde lokal epidemiyolojik verilerin dikkate alınmasının tedavideki başarı şansını arttıracağını, akılcı ve rasyonel antibiyotik kullanımını sağlayarak direnç oranlarını azaltacağı kanısındayız.
Anahtar Kelimeler: Antibiyotik Direnci; Mikroorganizma; Ortopedik Yara Enfeksiyonu.

INTRODUCTION

The primary task of the skin is to prevent the invasion of pathogenic microorganisms into subcutaneous tissues and to avert the settling of pathogenic microorganisms by creating skin flora. Wounds are created by traumas. Post-traumatic disruption of skin integrity leads to colonisation and invasion of microorganisms in the subcutaneous tissues. This is followed by the damage in the immune system caused by the microorganisms in the wound area and, then, infection of the wound (1). Infection in the postoperative or wound healing periods may arise from patient's own flora, hospital environment, or operation equipment. Hospital-acquired (nosocomial) infection is usually caused by antimicrobial resistant bacteria. Therefore, this type of infection is difficult to treat, not to mention that it is also costly and has high complication rates (2). There is a significant increase in the number of surgical interventions with the developments in orthopaedic surgery in recent years. Despite the advancements and improvements in asepsis and antisepsis applications, method of sterilisation, operating room and intensive care facility conditions and surgical techniques, and several prophylactic antibiotic applications, one of the most important and feared postoperative complications of modern orthopedic surgery is still infection of the surgical wound. Surgical wound infections developing in the postoperative period result in significant morbidity, mortality, loss of labor, extended hospital stay, and high costs (3). In spite of advances in diagnosis and treatment methods, irrational use of antibiotics and inadequate infection control policies give rise to microorganisms that develop rapid resistance even to the most effective antibiotics (4). Most of the orthopedic surgical wound infections are nosocomial (5). Therefore, systematic and realistic applications should be developed to reduce the risk of surgical wound infection caused by hospitals environment and staff.

This study aims at investigating the resistance rates of microorganisms and antimicrobial agents that have been isolated from wound infections in patients in inpatient and outpatient orthopaedics clinics in the postoperative period.

MATERIAL AND METHODS

Patients:

We have retrospectively studied the microorganisms isolated from wound samples of the postoperative patients from the inpatient and outpatient orthopaedics clinics of our hospital between June 2012 and June 2013. We have included the patients who developed infection in the early postoperative period (the first 4 weeks) in our hospital but did not receive any antibiotic treatment for the infection. Patients who had undergone operations in other centres and those who had previously received infection-related antibiotic treatment were excluded from the study.

Laboratory Tests:

The species identification of the isolated microorganisms was carried out by using conventional methods and an automatic system (Phoenix Becton Dickinson III). The in-vitro antimicrobial susceptibility of the isolated strains were determined according to the Clinical Laboratory Standards Institute criteria by using Kirby-Bauer disc diffusion method (Becton-Dickinson, Sparki Md, USA) on the automated system (6).

RESULTS

Within a period of 12 months, we isolated microorganism samples from 96 (37%) of the 257 postoperative patients from the inpatient and outpatient orthopaedics clinics. Of the 96 factors of the isolated wound samples, 72 (75%) were gram negative bacteria and 24 (25%) were gram positive bacteria. The most frequently isolated bacteria were acinetobacter spp. 24 (25%), Pseudomonas aeruginosa 19 (20%), Staphylococcus aureus 15 (16%), Escherichia coli 10 (10%), Klepsiell pneumonia 10 (10%), coagulase-negative staphylococci (CNS) 8 (8%), Proteus mirabilis 5 (5%), Enterobacter spp. 4 (4%), and Enterococcus spp. 1 (1%), respectively. We observed resistance in the Acinetobacter spp. strains to imipenem (92%), amikacin (83%), ciprofloxacin (89%), and SAM (62%). We detected beta-lactamase-positivity at an extended spectrum in E.coli (10%) and K. pneumoniae (40%) strains. There was no resistance to imipenem and amikacin in P. aeruginosa strains though these were resistant to ceftazidime, cefepime, piperacillin tazobactam with a resistance rate of 5%. 7% of the isolated S. aureus strains and 50% of the isolated KNS strains were methicillin-resistant while all strains were found to be resistant to vancomycin. The resistance rates of gram-positive strains showing their resistance to some antibiotics are given in Table 1; the resistance rates of gram-negative bacteria with respect to their resistance to various antibiotics are shown in Table 2.

Table 1. The resistance rates of gram positive strains.

Antimicrobial	*S.aureus* (n=15) Resistant (%)	KNS (n=8) Resistant (%)
Ciprofloxacin	1(%7)	3(%37)
Erythromycin	3(%20)	4(%50)
Gentamicin	1(%7)	1(%12)
Cefoxitin	1(%7)	4(%50)
Penicillin	11(%73)	7(%87)
Rifampin	1(%7)	4(%50)
Vancomycin	%0	%0
Tetracycline	3(%20)	3(%37)
Trimetoprim-Sulfametoxazol	2(%13)	2(%25)
Clindamycin	2(%13)	4(%50)
Ampicillin	4(%27)	-
Gentamicin 120	-	-
Streptomicin 300	-	-
Cloranfenicol	-	-

Table 2. The resistance rates of gram negative strains.

	E.coli (n=10) Resistant (%)	*K. pneumonia (n=10)* Resistant (%)	*Acinetobacter spp (n=24)* Resistant (%)	*P.aeruginosa (n=19)* Resistant (%)	Other Enterobactericeae (n=9) Resistant (%)
Ampicillin	8(%80)	-	-	-	4(%44)
Amoxicillin clavulanic acid	4(%40)	4(%40)	-	-	3(%33)
Cefoxitin	1(%10)	%0	-	-	-
Cefuroxime axetil	6(%60)	7(%70)	-	-	3(%33)
Cephalothin	7(%70)	8(%80)	-	-	4(%44)
Ceftazidime	1(%20)	4(%40)	18(%75)	1(%5)	1(%11)
Cefepime	1(%20)	4(%40)	22(%92)	1(%5)	1(%11)
Cefoperazone-sulbactam	%0	1(%10)	10(%42)	%0	%0
Piperacillin tazobactam	1(%10)	2(%20)	22(%92)	1(%5)	%0
Imipenem	%0	%0	22(%92)	%0	%0
Gentamicin	2(%20)	3(%30)	22(%92)	1(%5)	%0
Amikacin	%0	%0	20(%83)	%0	%0
Ciprofloxacin	1(%10)	1(%10)	19(%89)	1(%5)	%0
Netilmicin	-	-	17(%71)	%0	-
SAM	-	-	15(%62)	-	-
SXT	5(%50)	7(%70)	7(%39)	-	4(%44)
Tetracycline	4(%40)	7(%70)	8(%33)	-	5(%56)
ATM	1(%20)	4(%40)	-	1(%5)	1(%11)
CTX	2(%20)	4(%40)	19(%79)	14(%26)	1(%11)

DISCUSSION

Surgical wound infections is one of the major causes of mortality and morbidity in patients after surgery. Such infections delay the recovery of the clinical status of patients and lead to prolongation of hospital stay and increased costs (7). Since Joseph Lister's discovery of antiseptic applications in the 1860s, there has been an decrease in the high wound infection related postoperative morbidity rates. Currently, surgical wound infections constitute 14-16% of nosocomial infections which makes them the second most common type of infection among hospital-acquired infections (8). According to the Centre for Diseases Control and Prevention data, surgical wound infection is seen in 2-5% of all patients undergoing surgery (9). Depending on the surgeon, hospital, and surgical procedures, the incidence of surgical wound infections ranges from 1% to 40%. With an incidence rate of 22%, extending hospital stay with an average of 7.3 days, and increasing the hospital costs with an average of 3,152$, surgical wound infections is the second most common postoperative complication in Turkey (8).

Postoperative wound infection is the most important problem of modern orthopaedic surgery. It is very significant to conduct prophylaxis of infection consciously and effectively. Incomplete and incorrect treatment will develop resistance of bacteria and lead to increased morbidity and mortality rates (10). The post-surgical wound infection rates in Turkey have been reported by various researchers: Erbay et al. (11) 28%; Willke et al. (12) 20%; Geyik et al. (13) 36%; Yıldız et al. (14) 13%; and Demirtürk et al. (15) 16%. In our study, we isolated microorganisms in 96 (37%) of 257 wound samples of after orthopedic surgery and found out that 72 of these 96 (75%) were gram-negative bacteria while 24 (25%) were Gram positive bacteria.

In treating postoperative wound infections, regulating the treatment in the light of culture and antibiogram results will improve the success of treatment, shorten the length of hospital stay, and reduce costs. This will also increase the success rate of the practitioner and, with effective antibiotic use, block the dissemination of antibiotic-resistant strains (2). The reproduction of bacteria causing postoperative wound infection varies depending on the body area where the surgery is performed. Apart from patient's own bacterial flora, factors such as the already colonised bacterial species in hospital environments, particularly indoors in clinics, cause such infections (5). S. aureus, KNS, E. coli, and P. aeruginosa are among the most frequently isolated microorganisms in wound infections. Some of the isolation rates of these bacteria in Turkey have been listed below: Yurtsever et al. (2009) (16) E. coli 27%, P. aeruginosa 18%, S. aureus 18%, Acinetobacter baumannii 12%; Dogan et al. (2010) (2) E. coli 28%, P. aeruginosa 14%, S. aureus 15%; Demirturk et al. (2011) (15) E. coli 25%, P. aeruginosa 14%, S. aureus 28%; Bayram et al. (2013) (17); Acinetobacter baumannii 24%; P. aeruginosa 12%, S. aureus 11%, E. coli 10%. Some of the studies from abroad have provided the following rates: Guggenheim et al. (4) E. coli 14%, P. aeruginosa 12%, S. aureus 21% and Mulu et al. (18) E. coli 21%, KNS 21%, S. aureus 26%. In our study, the most common bacteria were Acinetobacter spp. (in 24 samples; 25%) and P. aeruginosa (in 19 samples; 20%). These are followed by S. aureus (in 15 samples; 16%), E. coli (in 10 samples; 10%), K. pneumoniae (in 10 samples; 10%), KNS (in 8 samples; 8%), P. mirabilis (in 5 samples; 5%), Enterobacter spp. (in 4 samples; 4%), and Enterococcus spp.(in 1 sample; 1%), respectively. High rates of Acinetobacter spp. and P. aeruginosa are revealing in showing the differences between the studies in Turkey and abroad but our findings match with the findings of Bayram et al.'s 2013 study (17). Chim et al.'s (19) study conducted in Singapore also reports high rates of Acinetobacter spp. but they explain this by the high proportion of potential Acinetobacter spp. already endemic on the skin flora of the people of the region. In our study, the high isolation rates of Acinetobacter spp. and P. aeruginosa can be interpreted as a sign that shows that these bacteria is well-colonised in our hospital.

Because of their ability to maintain long-term viability in the external environment and be transmitted easily through contamination, acinetobacter species have increasingly become important nosocomial pathogens (20). With regards to epidemiological and clinical aspects of the bacteria, bacterial resistance profile is very crucial. The Acinetobacter spp. strains we isolated had multiple resistance to antimicrobials. The Acinetobacter spp. that have been isolated in a similar manner in other studies were also found to be highly imipenem-resistant with a rate of 92% (16-20). The emergence of strains with multiple resistance to antimicrobials causes treatment to fail and increases morbidity and mortality. In line with previous studies on wound infections, we isolated P. aeruginosa with a rate of 20% even though our strains were not resistant to multiple antibiotics (4,15 to 20). Carbapenems, however, were found to be highly sensitive to aminoglycosides and fluoroquinolones.

Unlike earlier studies, S. aureus was the third most common form in our study by 16%. MRSA rate was very low (7%) as well. In former studies conducted in our hospital, this rate was 31% in 2011 (21) and 43% in 2013 (22). CNSs were methicillin-resistant up to 50%. The highest resistance rate in S. aureus isolates was to penicillin with a rate of 73%. We did not detect any glycopeptide resistance. The resistance rates to other antibiotics were also notably low: 7% to ciprofloxacin, 20% to tetracycline, 20% to erythromycin, and 7% to gentamicin, respectively.

Within the family Enterobacteriaceae (E. coli, K. pneumoniae, Enterobacter spp., and P. mirabilis), the rapid spread of ESBL strains raises concern all over the world (23). In our study carried out in our hospital in 2010, we identified an ESBL rate of 28% (24). In Turkey, in general, the HITTITE-2 study that was conducted between 2005 and 2007 determined this ratio as 42% (25). In our study, the ESBL positivity rates were 10% and 40% for E. coli and K.pneumoniae strains, respectively. In accordance with our 2010 study, Guggenheim et al.'s retrospective study (4) evaluating the data of 20 years has found the most effective antimicrobials to be imipenem and amikacin for ESBL positive strains. E. coli strains were most resistant to ampicillin by 80% while they were also highly resistant to cephalothin (by 70%) and cefuroxime axetil (by 60%). K. pneumoniae strains were found to be unsusceptible to trimethoprim-sulfamethoxazole, tetracycline, and cefuroxime axetil by 70% and to cephalothin by 80%.

In short, it is very essential to have the knowledge of the type and in vitro sensitivity of microorganisms to achieve appropriate medical treatment for postoperative infections. We believe that considering local epidemiological data in the treatment of postoperative surgical wound infections will increase the chances of success of treatment, reduce the rate of resistance by providing rational use of antibiotics, and contribute to the quality of health services by reducing costs.

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