Original Article ISSN (O):2395-2822; ISSN (P):2395-2814

Bacteriological and Antimicrobial Susceptibility Profile of Orthopaedic Surgical Site Infections

Suhail Malhotra[1], Simranjeet Kaur[2], Rajesh Kapila[3], Loveena Oberoi[4], Shailpreet Sidhu[5], Sita Malhotra[5], N. S. Neki[6]

[1]Senior Resident, Department of Orthopaedics, Govt. Medical College, Amritsar, Punjab, India.
[2]Junior Resident, Department of Microbiology, Govt. Medical College, Amritsar, Punjab, India.
[3]Professor, Department of Orthopaedics, Govt. Medical College, Amritsar, Punjab
[4]Professor, Department of Microbiology, Govt. Medical College, Amritsar, Punjab, India.
[5]Associate Professor, Department of Microbiology, Govt. Medical College, Amritsar, Punjab, India.
[6]Professor, Department of Medicine, Govt. Medical College Amritsar.

Received: September 2019
Accepted: September 2019

ABSTRACT

Background: Orthopedic implant site infection is major component of surgical site infection associated with high morbidity and mortality. Implants are foreign to the body so that orthopedic surgery is at risk of microbiological contamination .The changes in pathogenic flora has lead to emergence of antibiotic resistance creating problems in the management of orthopedic diseases. The aim of this study was to determine the type of bacterial pathogens isolated from surgical site infection (SSI) in Guru Nanak Dev Hospital attached to Govt. Medical College, Amritsar and their antibiotic sensitivity profile. **Methods:** During this period of study from August 2018 to July 2019, 509 pus samples were sent to microbiology department suspected as surgical site infection, from orthopaedic department of Government Medical College, Amritsar. Standard microbiological techniques were used to identify the organisms and determine the antibiotic susceptibility pattern as per CLSI guidelines. **Results:** In the study, out of 397 (77.6%) positive cultures, 109 (27.45%) Gram positive organisms were isolated among whom Staphylococcus aureus 92 (23.17%) was most common and 288 (72.54%) Gram negative organisms were isolated among whom Klebsiella species 90 (22.67 %) was most common isolate. **Conclusion:** S. aureus is the most common organism responsible for SSIs. Antibiotic preference should be made according to local sensitivity pattern of the hospital.

Keywords: Surgical site infection, Orthopedic implants site infections, bacteriological profile, Antimicrobial sensitivity, Staphylococcus aureus.

INTRODUCTION

The common orthopaedic infections are surgical site infections (SSI) and implant infections, both leading to devastating results in terms of morbidity and mortality in orthopaedic patients. The problem of change in pathogenic flora and bacterial resistance has complicated management of orthopaedic wound infections in developing countries.

Surgical site infection (SSI) is defined as infection at surgical site within 30 days of surgery or 90 days of implant placement. Surgical Site Infections (SSI) include three wound locations: superficial incisional, deep incisional and organ space SSIs.[1,2]

The incidence of SSI in orthopaedic patients varies from 0.8 and 71%.1,2 Global studies report the incidence of SSI in orthopaedic surgeries varies from 6% to 9% in low and middle income countries and 7-8% in high income or well developed countries in spite of well developed aseptic procedures, guidelines, surveillance and awareness programmes. The risk factors associated with development of SSI include co morbidities like diabetes mellitus, rheumatoid arthritis, malnourishment, obesity, immuosupression, presence of infectious foci in the body like UTI, infection control practices, prophylactic antibiotic administration, duration of surgery, duration of stay in hospital post-surgery and placement of drain at the surgical site and a blood transfusion during or post-surgery.[3-6]

A prosthetic replacement and an implant surgery in orthopaedic operations is successful for alleviating

Name & Address of Corresponding Author
Dr. Simranjeet Kaur,
Junior Resident,
Department of Microbiology,
Govt. Medical College, Amritsar,
Punjab, India

the pain and improving the mobility in damaged joints. These devices include prostheses for hip, knee, ankle, shoulder and elbow joints. They also include the fracture fixation devices such as wires, pins, plates, screws, etc. Metals (Ti-6Al-4V, Co-Cr-Mo and stainless steel), polymers [poly (methyl methacrylate) (PMMA) and ultrahigh-molecular-weight polyethylene(UHMWPE)] and ceramics (alumina, zirconia and hydroxyapatite)are the three classes of materials that are most commonly used for fabricating orthopedic implants.[7]

Prosthetic Joint Infections (PJIs) are devastating complications which follow such surgery. In the past century, the incidence of PJIs has drastically reduced due to the modern theatre facilities and the aseptic measures. Yet they still pose a problem in the developing countries, with high morbidities and substantial costs. The rate of PJI in most centers ranges between 0.5 to 1.0 percent for hip replacements, 0.5 to 2 percent for knee replacements, and less than 1 percent for shoulder replacements. The risk of prosthetic joint infection is greater for knee arthroplasty than hip arthroplasty.[8-12]

When microorganisms seed on a foreign body, they proliferate and undergo a phenotypic alteration to develop a biofilm. Biofilms resist the antibiotic penetration, thus requiring the dose to be increased several fold. Aggressive therapeutic options such as prolonged and high-end antibiotics, additional surgeries and a prolonged rehabilitation are associated with complications which require a prolonged hospitalization with a possibility of a renewed disability.[13]

This study was aimed at assessing the bacteriological profile and antimicrobial susceptibility which were associated with orthopaedic surgery and implant placement infections.

MATERIALS AND METHODS

This study was conducted for one year (August 2018 to July 2019) in the Department of Microbiology and Orthopaedics attached to a tertiary care hospital in Amritsar. The liquid pus samples, exudates and pus swabs from the surgical wounds of indoor and outdoor patients were sent by orthopaedics department for culture and sensitivity to Microbiology department. The samples were cultured on 5% Sheep Blood agar, MacConkey agar plates and a Brain Heart Infusion (BHI) broth. These were then incubated overnight at 37°C and then examined for the presence of any growth. The sterile plates were re-incubated till 48 hours. Subculture of the broths was done using standard procedure whenever it was indicated. The isolates were identified using conventional methods. Direct microscopy after Gram staining and standard biochemical tests were done.

Antimicrobial susceptibility test was done on Mueller Hinton Agar using Kirby Bauers Disk Diffusion method.

The first line antibiotics tested were penicillin (10U), cefoxitin (30µg) for MRSA, gentamycin (10µg), azithromycin (15µg), tetracycline (30µg), ciprofloxacin (5µg) and second line antibiotics linezolid (10µg) and vancomycin 30µg) and teicoplanin (30µg) were tested for the gram-positive bacteria.

For gram negative bacteria first line antibiotics tested were ampicillin, ceftriaxone, imipenem (10µg), ceftazidime (30µg), amikacin (30µg), amoxicillin-clavulanate, ciprofloxacin (5µg), piperacillin - tazobactam, sulbactum- cefepime, sulbactum-ceftazidime and second line antibiotics were polymyxin B (100/10µg), meropenem (10µg), ertapenem (10µg), and tigecycline (15µg). The diameters of the zones of inhibition were recorded and interpreted according to the CLSI guidelines 2018-2019.

RESULTS

During the one year study period, a total of 509 samples were received from orthopaedic department, out of which 397 (77.6%) samples showed culture positivity and 112 (22.0%) samples showed no growth.

In the study, out of 397 (77.6%) positive cultures, 109 (27.45%) gram positive organisms were isolated and 288 (72.54%) gram negative organisms were isolated.

The common gram positive isolates found in our study are Staphylococcus aureus, Enterococcus spp, Coagulase Negative Staphylococcus

The common gram negative isolates found in our study Klebsiella spp, Pseudomonas spp, Escherichia coli, Acinetobacter spp, Citrobacter spp, Proteus spp, Serratia marcescens.

Most common isolate was Staphylococcus aureus 92 (23.17%) followed by Klebsiella species 90 (22.67%), Pseudomonas species 74 (18.63%), Escherichia coli 73 (18.3%), Acinetobacter species 33 (8.31%), Citrobacter species 14 (3.52%), Coagulase negative Staphylococcus 9 (2.26%), Enterococcus species 8 (2.01%) Proteus species 3 (0.75%), Serratia marcescens 1 (0.25%). 9.8% of S. aureus was Methicillin resistant (MRSA)

All Staphylococci were susceptible to vancomycin, linezolid and teicoplanin. All gram negative bacilli were sensitive to Ertapenem, Imipenem and Meropenem.

The antibiotic susceptibility pattern of gram positive organism and gram negative organisms have been mentioned in tables below.

Table 1: Percentageof Cases Havingpositive And Negativeculture

Parameters	No. Of Cases (N =509)	Percentage
Total No. Of Culture Positive	397	78.0%
Total No. Of Culture Negative	112	22.0%
Total No. Of Cases	509	100%

Table 2: Distribution of Gram positive bacteria

S. No	Organism	Number	Percentage %
1.	Staphylococcus (MSSA +MRSA)	53+39 =92	84.40
2.	Enterococcus	8	7.33
3.	Coagulase Negative Staphylococcus	9	8.25
Total		109	100.00

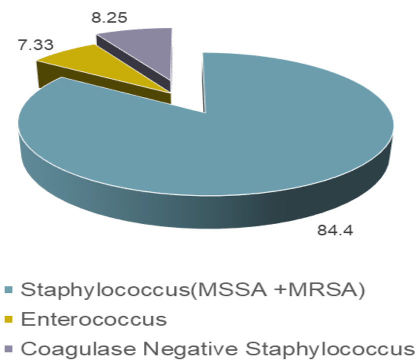

Table 3: Distribution of Gram Negative bacteria.

S. No	Organism	Number	Percentage %
1.	Klebsiella	90	31.25
2.	Pseudomonas	74	25.69
3.	Escherichia coli	73	25.34
4.	Acinetobacter	33	11.45
5.	Citrobacter	14	4.86
6.	Proteus	3	1.04
7.	Serratia marcescens	1	0.35
Total		288	100.00

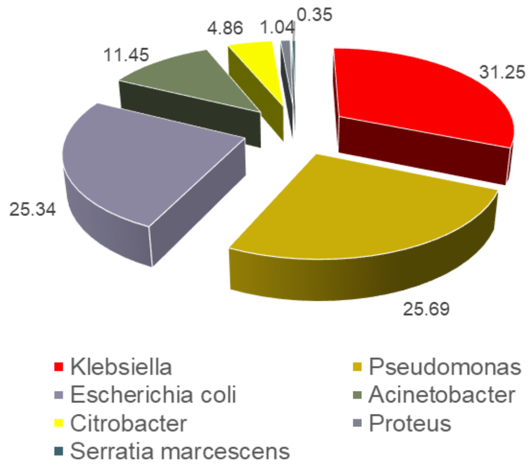

Table 4: Type of implant or orthopaedic procedures

S. No	Procedures	Number	Percentage %
1.	External fixator pin sites	158	54.86
2.	Distal tibial locking plate	102	35.42
3.	Tibia nail/proximal, tibia plate	60	20.83
4.	Foot implants and ankle implants (calcaneal plate, bimalleolar fixation)	38	13.19
5.	Femur (Nail, DSLC, DHS, PFN)	35	12.15
6.	Distal humerus plates	28	9.72
7.	Both bone forearm plates	23	7.99
8.	Humerus shaft plate/nail	15	5.21
9.	Clavicle plate	14	4.86
10.	Closed K wiring sites	12	4.17
11.	Hip arthroplasty	8	2.78
12.	Knee arthroplasty	7	2.43
13.	TBW sites (olecranon and patella)	6	2.08
14.	Universal spine stabilizing system	3	1.04

Table 5: Antimicrobial Sensitivity Pattern Of Grampositive Organisms

Organism	Penicillin	Cefoxitin	Azithromycin	Tetracycline	Gentamycin	Ciprofloxacin	Linezolid	Vancomycin
MSSA	0	100	83.45	91.02	64.50	64.63	100	100
MRSA	0	0	47.45	89.90	56.04	46.90	100	100
ENTERO	0	0	99.00	99.05	10	98	100	100
MSCONS	0	100	50.00	98.05	50	99	100	100
MRCONS	0	0	49.00	99.12	50	99	100	100

Table 6: Antimicrobial Sensitivity Pattern Of Gram Negative Organisms

Organism	Ampicillin	Amikacin	Gentamycin	Ciprofloxacin	Ceftazidime	Piperacillin-tazobactum	Sulbactum-ceftazidime	Sulbactum-cefepime	Ampicillin-sulbactum	Ertapenem	Imipenem	Meropenem
Klebsiella	0	85	85	86	57	86	78	52	63	100	100	100
Pseudomonas	-	90	74	52	69	85	79	54	64	100	100	100
E coli	6	90	73	39	48	84	81	55	49	100	100	100
Acinetobacter	7	96	92	86	89	99	98	95	92	100	100	100
Citrobacter	7	100	100	90	90	99	100	94	96	100	100	100
Proteus	50	90	90	96	58	92	98	95	96	100	100	100
Serratia	0	100	100	0	0	100	0	100	100	100	100	100

DISCUSSION

Orthopedic implant site infections continue to be a diagnostic and therapeutic challenge.

The results of the study show that most of the orthopedic SSIs are caused by S. aureus followed by Klebsiella species. Others include Pseudomonas species, Escherichia coli, Acinetobacter species, Citrobacter species, Coagulase negative Staphylococcus, Enterococcus species, Proteus species and Serratia marcescens.

In our study the culture positivity was found to be 77.6 % which is less when compared to other studies where Anisha Fernandez et al,[14] reported 84% and Khosravi et al,[15] Vishwajith et al,[16] reported the culture positivity of 93.9% and 94.89% respectively. However Gomez et al,[17] reported even lesser positivity of 60%. Most of the samples in our study were direct swabs which could have contributed to the low positivity rate.

One of the draw back of the study was not to culture for anaerobic organisms which can also cause implant site infections mostly beyond 24 months of the surgery, however no patient in the present study presented after that duration. Most of the patients had history of antibiotic treatment in the recent past which is again a factor against isolation of anaerobes.[18]

In another study in India Agrawal et al found out that the most common infecting organism in their institute was E. coli (34.4% cases) followed by Pseudomonas (26.1% cases) and then S. aureus in 21.6% cases. This is in contrast to our study wherein we found Pseudomonas species (18.63%), Escherichia coli (18.3%) cases only.[19]

In our study, 9.8 % of S. aureus was Methicillin resistant (MRSA) and all the MRSA isolates were sensitive to vancomycin, linezolid and teicoplanin. Mundhada and Tenpe similar also reported S. aureus as the most common bacteria isolated from the SSIs.[20] Many other studies have reported all the staphylococcal isolates being sensitive to vancomycin and linezolid. Currently vancomycin resistance Staphylococcus aureus (VRSA) is not widespread. Vancomycin remains the first choice of treatment for MRSA. The coagulase negative staphylococci (2.26%) were sensitive to vancomycin, teicoplanin and linezolid.

In an another study in India by Ravi Kant Das et al showed that most of the orthopedic SSIs in CIMS are caused by S. aureus followed by E. Coli. Others include Pseudomonas, Enterobacter, Coagulase negative Staphylococci and Acinetobacter. Overall Gram-negative bacteria are responsible for most of the SSIs.[21]

Based on the antimicrobial susceptibility data, we suggest that imipenem, ertapenem and meropenem are the most effective agents against most of gram negative bacteria and vancomycin, linezolid are the most effective agents against gram positive organisms. Tigecycline showed 100% sensitivity by all gram negative bacteria, but these drugs are kept as reserve, should be used judiciously.

CONCLUSION

Better understanding of the interaction between microorganisms, the implant and the host may improve our current approach to the diagnosis and treatment of implant-associated infections. Many factors must be considered while deciding antibiotic therapy like previous antibiotic history, knowledge of most common causative organism in these orthopedic infections, and their antibiotic profile. By multidisciplinary collaboration involving the orthopedic surgeons, and clinical microbiologist, we can further reduce the incidence of infection in our hospital.

REFERENCES

1. https://www.cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf
2. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections.Infect Control Hosp Epidemiol. 1992; 13(10):606-08.
3. Cooper RA. Surgical site infections: epidemiology and microbiological aspects in trauma and orthopaedic surgery: Int Wound J. 2013; 10(suppl. 1):3-8.
4. Khan MS, Rehman S, Ali MA, Sultan B, Sultan S. Infection in Orthopedic Implant Surgery, Its Risk Factors and Outcome. J Ayub Med Coll Abbottabad. 2008;20(1):23-5.
5. Ercole FF, Chianca TCM, Duarte D, Starling CEF, Carneiro M. Surgical Site Infection in Patients Submitted to Orthopedic Surgery: The NNIS Risk Index and Risk Prediction. Rev. Latino-Am Enfermagem. 2011;19(2):269-76
6. Fabin, TC, Minard, G. Sepsis. In: Mattox, K. L. (ed), Complication of Trauma. Newyork: Churchill Livingstone, 1994: 61-80.
7. Paital SR, Dahotre NB. Calcium phosphate coatingsfor bio-implant applications: Materials, performance factors, and methodologies. Mater Sci Eng Rep 2009;66:1-70.
8. NIH consensus conference: Total hip replacement. NIH Consensus Development Panel on Total Hip Replacement. JAMA 1995; 273:1950.
9. Berbari EF, Hanssen AD, Duffy MC , Steckelberg JM, IIstrup DM, Harmsen WS et al. Risk factors for prosthetic joint infection: case-control study. Clin Infect Dis. 1998; 27:1247.
10. Sperling JW, Kozak TK, Hanssen AD, Cofield RH. Infection after shoulder arthroplasty. Clinical Orthopaedics and Related Research. 2001;382:206-16.
11. Namba RS, Inacio MC, Paxton EW. Risk factors associated with deep surgical site infections after primary total knee arthroplasty: an analysis of 56,216 knees. J Bone Joint Surg Am 2013; 95:775.
12. Edwards JR, Peterson KD, Mu Y, Banerjee S, Allen-Bridson K, Morrell G, Dudeck MA, Pollock DA, Horan TC. National Healthcare Safety Network (NHSN) report: data summary for 2006 through 2008, issued December 2009. Am J Infect Control. 2009;37(10):783-805.
13. Costerton JW, Stewart PS, Greenberg EP. Bacterial biofilms: a common cause of persistent infections. Science 1999; 284: 1318-22.

14. Fernandes A, Dias M. The microbiological profiles of infected prosthetic implants with an emphasis on the organisms which form biofilms. Journal of Clinical and Diagnostic Research. 2013;7(2):219.
15. Khosravi AD, Ahmadi F, Salmanzadeh S, Dashtbozorg A, Montazeri EA. Study of bacteria isolated from orthopedic implant infections and their antimicrobial susceptibility pattern. Res J Microbiol. 2009;4:158-63.
16. Vishwajith A. K, Venkatesh. D. Evaluation of Aerobic Bacterial Isolates and its Drug Susceptibility Pattern in Orthopaedic Infections. Journal of Medical Science and Clinical Research. 2014;2(6):1256-62.
17. Gomez J, Rodriguez M, Banos V, Martinez L, Claver MA, Ruiz J, Simarro E, Canovas JA, Medina M, Clavel M. Orthopedic implant infection: prognostic factors and influence of long-term antibiotic treatment on evolution. Prospective study, 1992-1999. Enfermedades infecciosas y microbiologia clinica. 2003 May;21(5):232-6.
18. Spangehl MJ, Masri BA, O'connell JX, Duncan CP. Prospective analysis of preoperative and intraoperative investigations for the diagnosis of infection at the sites of two hundred and two revision total hip arthroplasties. JBJS. 1999 May 1;81(5):672-83.
19. Agrawal AC, Jain S, Jain RK, Raza HK. Pathogenic bacteria in an orthopaedic hospital in India. J Infect Dev Ctries 2008;2:120-3.
20. Mundhada AS, Tenpe S. A study of organisms causing surgical site infections and their antimicrobial susceptibility in a tertiary care Government Hospital. Indian J Pathol Microbiol 2015;58:195-200.
21. Das R, Singh A, Srivastava P, Pradhan S, Murthy R. Microbial Profile and Antibiotic Susceptibility Pattern of Surgical Site Infections in Orthopaedic Patients at a Tertiary Hospital in Bilaspur. Int J Sci Stud 2015;3(3):43-47.

How to cite this article: Malhotra S, Kaur S, Kapila R, Oberoi L, Sidhu S, Malhotra S, Neki NS. Bacteriological and Antimicrobial Susceptibility Profile of Orthopaedic Surgical Site Infections. Ann. Int. Med. Den. Res. 2019; 5(6):OR01-OR05.

Source of Support: Nil, **Conflict of Interest:** None declared