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Original Research Article

Aerobic bacteriological profile and antibiotic susceptibility pattern of surgical site infections in orthopaedic patients at tertiary care hospital: VIMS, Ballari

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Abstract

Introduction: In developing countries, the problem of changes in pathogenic microbial flora and the emergence of bacterial resistance have created major problems in the management of orthopaedic cases. The most dreaded complications in the minds of all orthopedicians is the fear of infection. Once frank infection develops then it's extremely difficult to treat. Objective: To determine the type of bacterial pathogens isolated from different orthopaedic cases in our hospital and their antibiotic sensitivity profile.

Materials and Methods: This study was conducted in the department of microbiology, VIMS Ballari, over a period of 1 year from Feb 2016 to Jan 2017. During this period 224 pus samples were collected from different orthopaedic cases. Standard microbiological techniques were used to isolate and determine antibiotic resistance pattern of organisms.

Results: Among 224 samples, 66.51% (149/224) specimens showed culture positivity. The most commonly isolated organisms were 74(45.39%) *Staphylococcus aureus*, 30 (40.54%) were Methicillin Resistant *Staphylococcus aureus* (MRSA) while 44(59.47%) were Methicillin Sensitive *Staphylococcus aureus* (MSSA), followed by *Pseudomonas aeruginosa* 43 (26.38%), *Klebsiella* spp. 24 (14.72%). No bacterial isolate was found to be sensitive to all antibiotics tested. All *Staphylococci* were susceptible to Vancomycin. Most of gram negative bacilli were sensitive to Piperacillin/ Tazobactam, Tobramycin, and Imipenem.

Conclusion: High rates of antibiotic resistance observed in our study, due to widespread usage of broad spectrum antibiotics. While deciding antibiotic therapy many factors must be considered like previous antibiotic history, knowledge of most common causative organism in these infections, and their antibiotic profile.

Keywords: Surgical site infections, Orthopaedic infections, Bacterial isolates, Antibiotic resistance.

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1. Introduction

Healthcare-associated infections (HAI) pose one of the most severe threats to patients' health and remain a major challenge for healthcare service providers' globally.[1]

According to the European Centre for Disease Prevention and Control, Surgical site infection defined as 'an infection that occurs within 30 days after the operation and involves the skin and subcutaneous tissue of the incision (superficial incisional) and/or the deep soft tissue (for example, fascia, muscle) of the incision (deep incisional) and/or any part of the anatomy (for example, organs and spaces) other than the incision that was opened or manipulated during an operation (organ/space)'.[2]

The global pooled incidence of Surgical Site Infection (SSI) was found to be 2.5% (95% CI: 1.6, 3.7). Based on the subgroup analysis by WHO region and survey period, the incidence of SSI was 2.7% (95% CI: 2.2, 3.3%) and 2.5% (95% CI: 1.8, 3.5%), respectively.[1] In India recent studies on SSI and Health Management Information System (HMIS) database (2019-20) showed SSI rate varying from 0.12% to 18%.[3]

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SSI poses a greater threat to orthopaedic surgeries than various others because of the usage of 'metallic implants' that harbour the pathogens thereby making the elimination of infection extremely difficult.[4,5,6]

The risk factors of SSI are patient-related (e.g., pre-existing infection, elderly age), procedure-related and operative environment-related (e.g., emergency surgery, inadequate antiseptic surgical site preparation, air quality of OT).[6,7,8,9]

The outcomes of SSI are prolonged hospital stay, development of multidrug resistant organism, high treatment costs and increased morbidity and mortality.[7,9,10,11]

Patients with SSI are twice as likely to die, 60% more likely to spend time in an intensive care unit (ICU), and more than five times more likely to be readmitted to the hospital after discharge.[12]

Surgical site infection (SSI) surveillance is an important part of hospital infection control practice.[13]

Breakthrough in the treatment of diseases led to increase in varied surgical interventions. Along with this, the magnitude of surgical site infections, use of antimicrobial agents, and emergence of antibacterial resistant strains are likely to increase gradually.

Therefore, the present study was undertaken to investigate the antimicrobial resistant pattern of pathogens from the SSIs of patients from the surgical hospitals of the study area. It is helpful for the better understanding of the spectrum of pathogens as well as their resistance pattern for prompt management of patients.

2. Materials and Methods

The present retrospective study "Aerobic bacteriological Profile and Antibiotic Susceptibility Pattern of Surgical Site Infections in Orthopaedic Patients at Tertiary Care Hospital VIMS, Ballari" was conducted in the Department of Microbiology, Vijayanagar Institute of Medical Sciences (VIMS), Ballari, for a period of 1 year, from Feb 2016 to Jan 2017. A total of 224 samples from surgical site infection (SSI), open fractures and operative wound infections were received irrespective of age and gender from clinically diagnosed orthopaedic cases.

Samples from the wounds were collected by two sterile swabs from clinically diagnosed cases of SSI from orthopaedic ward under aseptic precautions .One swab for Gram staining and other one for aerobic culture, plating on blood agar and Macconkey's agar and incubating at 37˚ for 18-24 hours.

During this period total 224 samples were collected and processed. When there was a growth, the isolates were identified by conventional microbiological methods including colony morphology and standard biochemical reactions. Antibiotic susceptibility tests were performed by Kirby Bauer disk diffusion method, according to the guidelines of Clinical and Laboratory Standards Institute (CLSI, M100-S12 document). Methicillin Resistant *Staphylococcus aureus* (MRSA) in isolated *S.aureus* was detected by cefoxitin disk diffusion method.

3. Results

Table 1: Percentage of cases having positive and negative culture

Parameters	No. of Samples	Percentage
Total no. of culture positive	149	66.51%
Total no. of culture negative	75	33.49%
Total no. of samples	224	100%

Out of 224 samples, 66.51% (149/224) specimens showed culture positivity. In which 163 were bacterial isolates. Among the 149 positive samples, 124 samples represented only a single isolate, 11 samples with two isolates, whereas 1 was with three isolates.(**Table 1**)

Table 2: Pattern of organisms

Organisms	Frequency	Percentage
Staphylococcus aureus	74	45.39 %
Pseudomonas aeruginosa	43	26.38%
Klebsiella spp	24	14.72%
Coagulase negative staphylococci (*CONS*)	13	7.97%
Streptococcus pyogenes	2	1.22%
Enterobacter spp	1	0.61%
Enterococcus spp	1	0.61%
E.coli	1	0.61%
Citrobacter spp	2	1.22%
Proteus spp	1	0.61%
Acinetobacter spp	1	0.61%
Total	163	100%

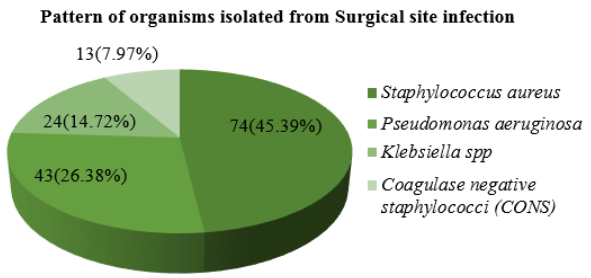

Figure 1: Pattern of organisms isolated from surgical site infection

1 Pie diagram and **Table 2**, showing distribution of organisms from surgical site infections (SSI).

Among 163 bacterial isolates, 90(55.21%) were Gram positive cocci and 73 (44.78%) were Gram negative isolates.

Out of 90(55.21%) Gram positive isolates, 74(45.39%) were *Staphylococcus aureus*, followed by 13(7.97%) *coagulase‑negative Staphylococcus* (CONS), 1(0.61%) *Enterococcus* spp., and 2(1.22%) were *Streptococcus pyogens*. Among 74 *S. aureus* isolates, 30(40.54%) were Methicillin Resistant *S. aureus* (MRSA) while 44(59.47%) were Methicillin Sensitive *S. aureus* (MSSA).(**Figure 1**)

The distribution of 73(44.78%) Gram negative isolates were *Pseudomonas aeruginosa* 43(26.38%) isolates followed by, 24(14.72%) *Klebsiella* spp. 2(1.22%), *Citrobacter* spp. 1(0.61%), *Acinetobacter* spp. 1(0.61%), *Proteus mirabilis* and 1(0.61%) *Enterobacter* spp.

Table 3: Antibiotic resistance pattern of predominant isolates

Antibiotic	***S. aureus* (n=74) MRSA 30)+MSSA(44)**	***CONS* (n=13)**	***Pseudomonas* spp (n=43)**	***Klebsiella* spp (n=24)**
Amikacin	24 (32.43%)	6 (46.15%)	12 (27.90%)	6 (25.00%)
Amoxicillin/Clavulanate	33 (44.59%)	7 (53.84%)	30 (69.76%)	10 (41.66%)
Ampicillin	57 (77.02%)	10 (76.92%)	30 (69.76%)	17 (70.83%)
Cefotaxime	NT	NT	17 (39.53%)	15 (62.50%)
Ceftriaxone	NT	NT	21 (48.83%)	15 (62.50%)
Ceftazidime	NT	NT	15 (34.83%)	14 (58.33%)
Ciprofloxacin	44 (59.45%)	6 (46.15%)	16 (37.20%)	13 (54.16%)
Cefoxitin	30 (40.54%)	NT	NT	NT
Clindamycin	32 (43.24%)	8 (61.53%)	25 (58.13%)	18 (75.00%)
Cotrimoxazole	30 (40.54%)	6 (46.15%)	13 (30.23%)	7 (29.16%)
Doxycycline	10 (13.51%)	5 (38.46%)	21 (48.83%)	4 (16.66%)
Erythromycin	20 (27.02%)	7 (53.84%)	NT	NT
Gentamicin	40 (54.05%)	6 (46.15%)	11 (25.58%)	7 (29.16%)
Vancomycin	00 (0.00%)	NT	NT	NT
Imepenem	NT	NT	2 (4.65%)	1(4.16%)
Linezolid	1(1.35%)	NT	NT	NT
Piperacillin-Tazobactam	NT	NT	2 (4.65%)	5 (20.83%)
Tobramycin	NT	NT	00 (0.00%)	4 (16.66%)
Cefpodoxime	NT	NT	1(2.32%)	6 (25.00%)

NT=Not Tested

The antimicrobial resistance profile of Gram positive and Gram negative isolates is as given in **Table 3**. As shown in **Table 3**, all the MRSA isolates were found to be sensitive to Vancomycin, 29 were sensitive to Linezolid. This indicates that MRSA isolates were having least resistance pattern towards Vancomycin and Linezolid respectively, while there was a high resistance towards Ampicillin, Ciprofloxacin, and Gentamicin. Among the other isolates, high degree of resistance was to Amoxicillin/Clavulanate, Ciprofloxacin, and Gentamicin in MSSA isolates; to Ampicillin, and Clindamycin in *CONS*; to Amoxicillin/clavulanate, Ampicillin, Ceftriaxone, Clindamycin, and Doxycycline in *Pseudomonas* sp., and to Clindamycin, Ampicillin, Cefotaxime and Ceftriaxone in *Klebsiella* spp. Most of the isolates were sensitive to the Piperacillin/ Tazobactam, Tobramycin, Cefpodoxime and Imipenem.

4. Discussion

Table 4: Representing gram positive and gram negative isolates, along with the most frequent isolate of different studies.

Author of study	**Percentage of Positive isolates**	**Percentage of Gram positive isolate**	**Percentage of Gram Negative isolate**	**Most frequent isolate**
Malhotra et al.[5]	77.6%	27.45%	72.54%	*Klebsiella* spp (31.25%)
Sharnathe et al.[19]	58.01%	55.98%	44.02%	*Staphylococcus aureus* spp (53.92%)
Khan, et al.[10]	52.2%	41%	57.1%	*Staphylococcus aureus* (24.2%)
Budhani D et al.[22]	57.5%	31.6%	68.4%	*Staphylococcus aureus* (25.5%)
Ali et al.[16]	83.7%	43.75	56.25	*Staphylococcus aureus* (29.2%)
Nidhi S Patel et al.[17]	31.19%	10.29%	89.70%	*Klebsiella* species (44.26%)
Misha et al.[21]	71.7%	11.5%	78%	*Escherichia coli* (21.43%)
Rajani et al.[14]	91.31%	30.43%	69.57%	*Staphylococcus aureus* (30.43%) (Including *Coagulase negative Staphylococcus*)

Narula, et al.[15]	86.27%	43.75%	56.25%	*Staphylococcus aureus* (35.16%)
Kochhal N et al.[20]		16.67%	83.33%	*Escherichia coli* (33.33%)
Patel, et al.[18]	40.8%	21.57%	78.43	*Klebsiella pnuemoniae* (23.53%)
Alelign et al.[6]	34.9%-	42.1%	57.9%	*S. aureus* (25%)
Banik et al.[3]	78.64%	24.79%	75.21%	*Klebsiella pneumonia* (26.34%)
Presesnt study	66.51%	55.21%	44.78%	*S. aureus* (45.39%)

Orthopaedic surgical site infections continue to be a diagnostic and therapeutic challenge.

As shown in **Table 4**, Result of the study shows that, most of the orthopaedic SSIs are caused by *S. aureus* followed by *Pseudomonas aeruginosa*. Others include *Klebsiella* spp, *Coagulase negative staphylococci, Streptococcus pyogene, Enterobacter* spp, *Enterococcus* spp, *E.coli, Citrobacter* spp, *Proteus* spp and *Acinetobacter* spp. In our study, culture positivity was found to be 66.51% which is less when compared to other studies Rajani et al, Narula et al, and Ali et al reported culture positivity of 91.31%, 86.27% and 83.7% respectively.[14,15,16] However, Nidhi S Patel et al and Patel, et al reported even lesser culture positivity of 31.19%, and 40.8% respectively.[17,18] Most of samples in our study were direct swabs which could have contributed to the low positivity rate.

Gram positive isolates (55.21%) were more common in our study than gram negative isolates (44.78%). This outcome aligns with the study by Sharnathe et al where Gram positive isolates were 55.98%.[19] Few other studies produced results that are in opposition to this, indicating that gram negative isolates are more prevalent than gram positive isolates, Malhotra et al, Nidhi S Patel et al, Banik et al, 72.54%, 89.70%, and 75.21% respectively.[5,7,17]

S. aureus 74(45.39%) is the most frequently isolated bacterium in the current study, followed by *Pseudomonas aeruginosa 43(*26.38%), and *Klebsiella* spp 24(14.72%).This result is nearly consistent with the study by Sharnathe et al, Narula, et al ,Khan, et al, where *Staphylococcus aureus* was a predominant isolate with the rate of 53.92%, 35.16%, and 24.2% respectively.[10,15,19]

Table 5: Percentage of Methicillin Resistant *Staphylococcus aureus* (MRSA) in different studies.

Author of study	Percentage of MRSA
Malhotra et al.[5]	9.8 %
Sharnathe et al.[19]	28%
Budhani D et al.[22]	68.3%
Ali et al.[16]	42.86%
Narula et al.[15]	43.75%
Patel et al.[18]	36.36%
Alelign et al.[6]	57.9%
Banik et al.[7]	43.9%
Present study	40.54%

Conversely, number of other Studies Malhotra et al, Patel, et al. Banik et al have demonstrated that, the isolate most frequently detected in surgical site infection is *Klebsiella* spp. with the isolation rate of 31.25%, 23.53%, 26.34% respectively.[5,7,19] Also, in few other studies Kochhal N et al, Misha et al, have shown *Escherichia coli* as most frequently isolated gram negative bacilli with the rate of 33.33% and 21.43% respectively.[20,21]

In present study, frequently isolated gram positive isolates have shown antibiotic resistance towards Ampicillin, Ciprofloxacin, and Gentamicin, but higher susceptibility has been recorded against Linezolid and Vancomycin. A significant proportion of Gram positive cocci were MRSA 30(40.54%%), similar results were seen by Ali et al, Narula, et al Banik et al, where, MRSA rate was 42.86%,43.75%, and 43.9% respectively.[7,15,16] In few other studies Budhani D et al and Alelign et al demonstrated higher findings 68.3%, 57.9% respectively.[6,22] Study by Malhotra et al MRSA rate was 9.8 %, which was much lower than our findings.[5] Also, lower rate of MRSA (28%) was demonstrated in a study by Sharnathe et al.[19] As MRSA has predominant role in healthcare associated infections, higher isolation of MRSA from SSI samples indicates need of better infection control practices.(**Table 5**)

In our study, among frequently isolated gram negative isolates, high antibiotic resistance was noted to Amoxicillin/Clavulanate, Ampicillin, Ceftriaxone, Clindamycin, Cefotaxime and Doxycycline.This was in consistent with the studies Sharnathe et al and Ali et al where gram negative isolates demonstrated more resistance to Ampicillin, and ceftriaxone.[16,19] While, in a study Narula et al resistance was more towards Amoxycillin‑clavulanic acid.[15] In few other studies Patel et al and Alelign et al Ampicillin has shown more resistance.[6,18]

Most of the isolates were sensitive to Piperacillin/ Tazobactam, Tobramycin, Cefpodoxime and Imipenem. This sensitivity pattern was similar to other studies Budhani D et al, Rajani et al and Sharnathe et al, where gram neagative isolates were sensitive to Piperacillin/ Tazobactam, and Imipenem.[14,19,22] Few other studies Narula et al and Patel et al gram negative isolates were sensitivity to Carbapenems.[15,18]

Based on the antimicrobial susceptibility data, Piperacillin/ Tazobactam, Tobramycin, Cefpodoxime and Imipenem are the most effective agents against most of gram negative bacteria and Vancomycin, Linezolid are most effective agents against gram positive organism.

5. Limitation

The limitations of this study are, we did not study the risk factors, operative variables affecting development of SSI. The other limitation in our study was anaerobic bacterial and fungal cultures were not done. Prior to sampling, the administration of antimicrobial prophylaxis and antiseptics may have influenced the outcome of our investigation.

6. Conclusion

The present study reveals that, most of the pathogens associated with the SSIs in the study area are Gram positive and predominantly *S. aureus*. Among these, 40% are MRSA which showed multidrug resistance pattern. To effectively address the challenges posed by antibiotic resistance in orthopaedic surgical site infections, it is crucial to implement a multi-faceted approach. First, regular surveillance of bacterial pathogens and their susceptibility patterns should be conducted to inform empirical treatment choices. To enhancing infection control protocols, including proper sterilization techniques and preoperative antibiotic prophylaxis, can significantly reduce the incidence of surgical site infections.

7. Ethical approval

The study was approved by Institutional Ethics Committee, VIMS, Ballari, Karnataka.

8. Conflict of Interest

There is no conflict of interest.

9. Source of Funding

None.

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