Original Article

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Microbial Profile and Antibiotic Susceptibility Pattern of Surgical Site Infections in Orthopedic Patients at a Tertiary Hospital in Bilaspur

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Abstract

Introduction: The most dreaded complication in the minds of all orthopedicians is the fear of infection. Once frank infection develops then it is extremely difficult to eradicate. One of the proven measures to prevent infection is early deployment of appropriate antibiotic before the development of frank infection.

Purpose: To find out and study the microbial profile amongst the orthopedic surgical site infections (SSIs) in Chhattisgarh Institute of Medical Sciences (CIMS) and find out the appropriate antibiotics for empirical therapy in orthopedic cases.

Study Design: Retrospective study.

Protocol and Procedure: All cases which underwent orthopedic procedure or surgery from 1st March 2014 to 31st February 2015 were segregated and their culture and sensitivity reports were collected. The common infecting organisms were identified based on the culture and sensitivity reports and the most appropriate antibiotic to which most of the infecting bacteria were sensitive was found out.

Observation and Results: Culture reports of 308 post-operative patients who underwent orthopedic procedure revealed SSI in 37 cases (12%). We found out that the most common infecting bacteria causing most of the orthopedic SSIs was *Staphylococcus aureus* (24.3%) and was followed by *Escherichia coli* (18.9%), *Pseudomonas* (18.9%), then *Enterobacter* spp. (8.1%) and *Achromobacter* (8.1%) and others in that order. Most of the *Staphylococci* were sensitive to linezolid and sensitivity to amoxicillin + clavulanic acid was also good. For Gram-negative infection (*Enterobacteriacae*) piperacillin + tazobactam, cefoperazone + sulbactam and amikacin were found highly sensitive. For *Pseudomonads* again piperacillin + tazobactam was found out to be very effective.

Conclusion: *S. aureus* is the most common organism responsible for SSIs. A combination of piperacillin-tazobactam or cefoperazone sulbactam along with amikacin should be used as empirical therapy in orthopedic cases at CIMS to reduce SSIs.

Key words: Antibiotic susceptibility pattern, Microbiological profile, Orthopaedic surgery, Surgical site infections

INTRODUCTION

Infections in orthopedics are difficult to treat. It is always better to prevent the infection rather than to treat it. Once frank infection develops the management becomes primarily surgical with repeated debridements and may even lead to implant removal. Not only it is a physical ailment for the patient, but also adds to his psychological and financial load.[1] The patient, if untreated or irrationally treated goes in for serious life-threatening and limb-threatening consequences and may also land up in an emotional breakdown.

The management of these infections requires a close collaboration of the surgeon or treating doctor and his team. The infecting organism has to be identified as early as

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possible and the drugs to which the organism is susceptible have to be instated.[2]

Generally in any orthopedic case a pair of antibiotics covering both the Gram-negative and Gram-positive infections are employed.[3] Whenever there is suspicion of an anaerobic infection, another antibiotic for anaerobes is added.[4] This is a practical protocol followed in many institutes. However, injudicious use of antibiotics may lead to antibiotic resistance and decreased patient immune response. Prompt use of the most sensitive antibiotics as early as possible as empirical therapy, to which most of the common infecting bacteria would succumb will help us in preventing frank life and limb-threatening infections.

So, we conducted this study jointly in the Department of Orthopaedics and Microbiology in Chhattisgarh Institute of Medical Sciences (CIMS) to establish the microbiological profile of the bacterial infections and to find the most appropriate antibiotics against these organisms.

PROTOCOL AND PROCEDURE

This was a retrospective study conducted jointly in the Department of Orthopaedics and Microbiology. A blanket consent was taken from all patients, at the time of admission, that they are willing for any type of medical and surgical procedure and that their treatment information will be used for study and research purposes also, warranting them of the complete privacy of their entrusted personal information. Before starting the study, an Ethical Clearance certificate was taken from the Ethical Committee of our Medical College. The culture and sensitivity reports of all orthopaedic cases operated between 1st March 2014 and 28th February 2015 were collected. All operated orthopaedic cases in our institute have their swab sent from the surgical site for microbiological analysis.

The samples in the lab were inoculated in blood agar and MacConkey agar and incubated at 37°C in candle jar.[5] The growth then obtained was put to tests for identification of the bacteria. The tabulation of the data was done to find out the commonly infecting organisms and the frequency of these infections was found. The data were organized in decreasing order of the frequency of infection with the most commonly infecting organism first followed by the others.

The next step was to identify the antibiotics to which most of these organisms were susceptible. The sensitivity in the institute is done by the Kirby–Bauer disc diffusion method. In this method lawn culture on Muller Hinton Agar media is prepared with the microbes from the samples. Antibiotic impregnated discs are kept on the surface of the plates before incubating these plates for 24 h at 37°C in a candle jar. The interpretation of the test was done according to CLSI guidelines as sensitive, intermediate and resistant (Figure 1).[6]

After identification of the commonly affecting micro-organism the most sensitive antibiotics were identified. The data were organized and the antibiotics to which most of the organisms were sensitive and had least resistance were identified.

OBSERVATIONS AND RESULTS

A total of 308 operated patients whose swab was sent for culture and sensitivity as a standard protocol were identified in the desired time period and their reports traced. Of them, 37 patients had growth of organisms indicating surgical site infections (SSI). The overall rate of surgical site orthopedic infections was found to be 12%.

The organisms were broadly divided into 3 groups - Gram-positive staphylococci, the Gram-negative *Enterobacteriacae* and the *Pseudomonads*. The Gram-positive *Staphylococci* included *Staphylococcus aureus* and Coagulase negative *Staphylococci*. The Gram-negative *Enterobacteriacae* included the *Enterobacter*, *Escherichia coli*, *Klebsiella* and *Proteus*. The *Pseudomonads* included *Peudomonas* spp., *Achromobacter* and *Acinetobacter*. There were 11 (29.7%) infections out of 37 caused by the Gram-positive *Staphylococci*. The Gram-negative infections caused by *Enterobacteriacae* dominated the list with 15 (40.54%) infections and the *Pseudomonads* caused 11 (29.7%) infections. The distribution of these organisms is depicted in Table 1.

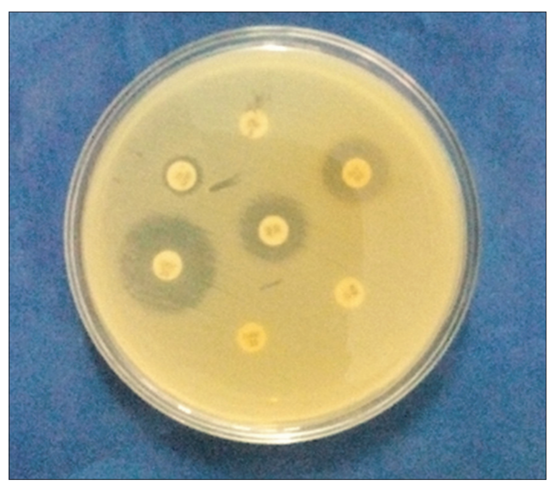

Figure 1: A photograph of antibiotic disc in carpet growth over Muller Hinton Agar, showing zone of inhibition for the antibiotics. A Kirby–Bauer disc diffusion method

The single most commonly infecting organism was found to be *S. aureus* which had been isolated from 9 samples (24.3% cases). It was followed by *E. coli* and *Pseudomonas* in 7 cases each (18.9% cases). Then, it was *Achromobacter*, *Enterobacter* spp., and *Klebsiella* with 3 cases each (8.1% cases) followed by *Proteus* and Coagulase negative Staphylococci with 2 (5.4%) cases each. One SSI was attributable to *Acinetobacter* (2.7%) (Table 2).

It is evident that the most effective antibiotics for the treatment of Gram-positive infections (caused mostly by *S. aureus* and Coagulase negative Staphylococci) are linezolid and vancomycin effective against 90.9% and 81.8% bacteria respectively. However, we do not recommend the empirical use of these antibiotics for the fear of emerging drug resistance. These are higher antibiotics and are to be used only in life-threatening infections or when an infectious agent is insensitive to other commonly used drugs. The other drugs which were found extremely useful for the treatment of Gram-positive infections are amoxicillin + clavulanic acid (72.3%) and cefoperazone + sulbactam (72.3%). Ofloxacin also had similar results (sensitive in 72.3% cases) (Table 3).

Table 1: Distribution of organisms causing SSI in orthopedics

Infecting *Microbacteria*	Number of cases	Percent
S. aureus	9	24.3
E. coli	7	18.9
Pseudomonas	7	18.9
Achromobacter	3	8.1
Enterobacter	3	8.1
Klebsiella	3	8.1
Proteus	2	5.4
Coagulase negative *Staphyloccoccus*	2	5.4
Acinetobacter	1	2.7
Total	37	99.9

S. aureus: Staphylococcus aureus

Table 2: Antibiotic susceptibility pattern of Gram-positive *Staphylococci*

Antibiotic	Sensitive (%)	Intermediate (%)	Resistant (%)
Piperacillin - tazobactam	7 (63.6)	1 (9.1)	3 (27.3)
Cefoperazone sulbactam	8 (72.73)	1 (9.1)	2 (18.2)
Ampicillin+sulbactam	8 (72.73)	-	3 (27.3)
Amoxicillin+clavulanic acid	8 (72.73)	1 (9.1)	2 (18.2)
Ciprofloxacin	7 (63.6)	1 (9.1)	3 (27.3)
Ofloxacin	8 (72.73)	1 (9.1)	2 (18.2)
Amikacin	6 (54.54)	1 (9.1)	4 (36.4)
Gentamycin	6 (54.54)	-	5 (45.45)
Linezolid	10 (90.9)	1 (9.1)	-
Vancomycin	9 (81.81)	2 (18.2)	-
Amoxicillin	5 (45.45)	1 (9.1)	5 (45.45)
Oxacillin	9 (81.81)	-	2 (18.2)

n=11 (total)

It can be seen that, if the growth yields a Gram-negative *Enterobacteriacae* (*E. coli*, *Enterobacter*, *Proteus* and *Klebsiella*) then the sensitivity pattern is different. The Gram-negative rods are more sensitive to piperacillin + tazobactam. About 73.3% of all Gram-negative *Enterobacteriacae* were found sensitive to piperacillin + tazobactam and cefoperazone + sulbactam. Furthermore, amikacin was found sensitive against 73.3% Gram-negative *Enterobacteriacae*. Highest sensitivity with low resistance were obtained with imipenem and cilastatin (93.3%), but they are not recommended for empirical use (Table 4).

The emerging trend of infection shows an alarming rise in the *Pseudomonad* infections. The *Pseudomonads* include *Pseudomonas* Spp., *Achromobacter* and *Acinetobacter*. The *Pseudomonads* are also highly sensitive to piperacillin + tazobactam which was found effective in 82.8% infections with *Pseudomonads*. The other drugs with high sensitivity against the *Pseudomonads* were cefoperazone + sulbactam (72.23% cases) and amikacin (54.5% cases).

A supplementary finding in the study was that the risk factors for development of SSI when traced back were duration of the surgery, open fractures, crowding of the operating room, presence of co-morbid conditions,

Table 3: Antibiotic susceptibility pattern of Gram-negative *Enterobacteriacae*

Antibiotic	Sensitive (%)	Intermediate (%)	Resistant (%)
Amikacin	11 (73.3)	1 (6.7)	3 (20)
Gentamycin	7 (46.7)	3 (20)	5 (33.3)
Cefoperazone sulbactam	11 (73.3)	2 (13.3)	2 (13.3)
Ciprofloxacin	7 (46.7)	3 (20)	5 (33.3)
Ofloxacin	8 (53.3)	2 (13.3)	5 (33.3)
Piperacillin+tazobactam	11 (73.3)	2 (13.3)	2 (13.3)
Ceftriaxone	8 (53.3)	3 (20)	4 (26.7)
Amoxicillin+clavulanic acid	7 (46.7)	2 (13.3)	6 (40)
Imipenem	13 (86.7)	1 (6.7)	1 (6.7)
Imipenem+cilastatin	14 (93.3)	1 (6.7)	-
Meropenem	11 (73.3)	1 (6.7)	3 (20)

n=15 (total)

Table 4: Antibiotic susceptibility pattern of *Pseudomonads*

Antibiotic	Sensitive	Intermediate	Resistant
Ciprofloxacin	4 (36.4)	1 (9.1)	6 (54.54)
Ofloxacin	5 (45.5)	1 (9.1)	5 (45.5)
Gentamycin	5 (45.5)	1 (9.1)	5 (45.5)
Amikacin	6 (54.54)	1 (9.1)	4 (36.4)
Cefoperazone+sulbactam	8 (72.73)	-	3 (27.3)
Meropenem	8 (72.73)	1 (9.1)	2 (18.2)
Piperacillin+tazobactam	9 (81.81)	1 (9.1)	1 (9.1)
Imipenem	9 (81.81)	-	2 (18.2)
Imipenem+cilastatin	10 (90.9)	-	1 (9.1)

n=11 (total)

duration of drainage tube insertion and general hygiene of the patient.

DISCUSSION

In this study, we have found out that the rate of SSI in orthopedics in our institute is 12%. This is better than those reported by Maksimovic *et al.*[7] where they reported an infection rate of 22.7%. They had 63 patients out of 277 operated patients who developed infection.

The results of the study show that most of the orthopedic SSIs in CIMS are caused by *S. aureus* followed by *E. Coli*. Others include *Pseudomonas*, *Achromobacter*, *Enterobacter*, Coagulase negative *Staphylococci* and *Acinetobacter*. Overall Gram-negative bacteria are responsible for most of the SSIs.

With the overall drug sensitivity pattern it is recommended that for empirical therapy we should start with a combination of cefoperazone + sulbactam or piperacillin + tazobactam along with amikacin as these drugs have been found to be uniformly sensitive against all bacteria including the Gram-positive *Staphylococci* or the Gram-negative *Enterobacteriacae* or the *Pseudomonads*. If resistance against these antibiotics is found then the drugs we recommend are linezolid or vancomycin for Gram-positive *Staphylococci* and imipenem + cilastatin for resistant *Enterobacteriacae* and *Pseudomonads*.

When we have identified the type of growth and infecting organism then we recommend the empirical use of amoxicillin + clavulanic acid or cefoperazone + sulbactam along with ofloxacin in cases of Gram-positive *Staphylococcal* infections as each of them were found effective in 72.73% of infections with Gram-positive *Staphylococci*.

For Gram-negative infections our recommendation is to start with a combination of piperacillin + tazobactam or cefoperazone + sulbactam and amikacin. The same combination is to be used in the case of *Pseudomonads*.

A point worth mentioning here is that the Gram-negative *Enterobacteriacae* and the *Pseudomonads* both show extremely high sensitivity to imipenem + cilastatin, but these drugs are extended spectrum beta-lactams and relatively newly emerged drugs with less known resistance. So, empirical therapy with imipenem + cilastatin is not recommended for the fear of emergence of drug resistance. They, like linezolid for Gram-positive *Staphylococci*, are to be kept as reserved drugs to be used in infections caused by organisms resistant to other drugs or life-threatening infections.

Our results are in accordance with the study of Benabdeslam *et al.*[1] wherein they also had isolated *S. aureus* as their most commonly infecting organism in 33.1% cases.

Also, the results are concurrent with the study of Dhawan *et al.*[3] wherein they also found out that the most common micro-organism causing orthopedic infection is *S. aureus*. They found out that almost 40% of the inpatient wound infections and 62% of out-patient wound infections in orthopedics in their institute were caused by *S. aureus*.

Also in another study by Mundhada and Tenpe[2] similar results were obtained and *S. aureus* was the most common bacteria isolated from the SSIs.

The results of our study are contradictory to the results of Thool *et al.*[8] wherein they had found that 12 out of 51 isolated staphylococcus samples were resistant to linezolid. However, in our study we found linezolid resistance *S. aureus* (LRSA) was not found in the *Staphylococci*. We also conclude that linezolid is one of the most effective therapeutic agents against *S. aureus*.

In another study in India Agrawal *et al.*[9] 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 *E. coli* and *Pseudomonas* each in 18.9% cases only. However, their study was a broad study dealing with all sorts of orthopedic infections including bedsores, osteomyelitis, open fractures etc. This might be a reason for the difference in organism pattern obtained. They had also recommended that the first drug of choice to be used in orthopedic infections is cefoperazone which is partly in accordance to our study where we have recommended a combination of cefoperazone + sulbactam and amikacin for empirical treatment in orthopaedic cases.

With the great increase in the level of orthopedic surgery and with the evolution of techniques such as arthroscopy, recent advances in spine surgery and evolution of the modern arthroplasties the risk of infection is a great threat. It is always better to prevent the development of frank infection with prompt drugs and know the microbial profile of the infections in that area so that measures could be taken to prevent them. We all know that implant infections and osteomyelitis might just be the most difficult morbidities to treat. Osteomylitic patients may even land up in amputations.

In all centers antibiotics to prevent infections in the post-operative period are given and the chances of developing an infection after giving these empirical antibiotics are still present. With the results of our study, by starting a combination of piperacillin + tazobactam or cefoperazone + sulbactam and amikacin, orthopedic infections in our institute can be prevented and taken care of in the early and subclinical phase and the chances of development of suppurative frank infections would be grossly lowered.

CONCLUSION

The data suggests that there is preponderance of Gram-negative infections in operated orthopedic patients, but *S. aureus* predominates the infectious agents as the sole pathogen.

Administration of empirical antibiotic should be based on the local microbiological data. In first study of this kind in the tribal dominated region of Chhattisgarh it is obvious that by starting a combination of piperacillin + tazobactam or cefoperazone + sulbactam along with amikacin would definitely bring about a decrease in the rate of SSIs in our institute.

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