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Original Article

Microbiology Section

Microbiological Profile of Orthopaedic Implant Associated Infections: A Prospective Study

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ABSTRACT

Introduction: The incidence of orthopaedic implantation and implantation associated infections were correspondingly increasing among the elderly and trauma patients. The resistance among the pathogens pose a unique challenge to the clinicians in the management of the infection. Extended-Spectrum Beta-Lactamase (ESBL), AmpC beta-lactamases (AmpC), Metallo Beta-Lactamases (MBL) and Methicillin-Resistant Staphylococcus aureus (MRSA) producing bacterial pathogens are responsible for a high rate of relapsing infections and outbreaks of nosocomial infections.

Aim: To focus on accounting the incidence of ESBL, AmpC, MBL and MRSA and its antibiogram for effective management of implant associated infection.

Materials and Methods: The present study was a prospective observational study which was conducted using various samples like pus, wound swab, serous discharge. These samples were collected under aseptic precautions in sterile containers for the period of one year (February 2015-February 2016). A total of 200 samples were inoculated on Blood agar and McConkey agar and identified. The isolates were tested for detection of ESBL, AmpC, MBL and MRSA as per standard protocol. The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) software version 20.0 Chicago, USA.

Results: Most commonly used implants were intramedullary interlocking nail 138 (65.7%) followed by dynamic compression plates 23 (11.0%) and anatomical plates 18 (8.6%). Of the total of 200 samples, 190 (95%) samples yielded monomicrobial isolates and 10 (5%) samples yielded polymicrobial isolate. gram negative isolates 108 (51.4%) were marginally higher than gram positive isolates 102 (48.6%). The predominant isolate was *S. aureus* 81 (38.5%) followed by *Klebsiella* spp. 28 (13.3%) and *Pseudomonas aeruginosa* 21 (10.0%). In gram negative isolates, 76 (70.4%) were ESBL and/or AmpC producers. Of which, 48 (44.4%) were ESBL and AmpC co-producers. There were no MBL producing isolates. In gram positive isolates, majority were *S. aureus* 81 (79.4%) followed by Coagulase-negative *Staphylococcus* 21 (20.6%). Out of 81 *S. aureus* isolates, 46 (56.8%) were MRSA. Out of 21 CoNS, majority 17 (81%) isolates were methicillin-resistant. Implant failures were observed in 28 (14%) cases. Out of 28, majority 12 (42.8%) of the implant failures were MRSA.

Conclusion: High rates of ESBL, AmpC and MRSA infections associated with implant surgeries indicate the necessity to formulate antibiotic policies and control measures. ESBL and AmpC producing strains were found to show higher rates of resistance to the various class of antibiotics when compared to non-ESBL and non-AmpC producers. MRSA isolates were found to show higher rates of resistance to various classes of antibiotics when compared to MSSA.

Keywords: Extended-spectrum beta-lactamase, Implant infections, *Staphylococcus aureus*

INTRODUCTION

The application and advancement of biomedical materials as implantable devices becomes indispensable in the field of medicine. These implant associated infections contribute to aggregating nosocomial infections. In about 0.02-0.9% of patients, the implant associated infection leads to the devastating complication. The infection at the surgical site will double the hospital stay and also increases healthcare expenditure and in a few cases which also results in amputation and mortality. Treating implant associated infection is a challenging task as in severe case it leads to implant failure [1-5].

Biofilm formation and antibiotic resistance of adhering bacteria reflect the severity of implant-associated infections. ESBL and AmpC Beta-Lactamase producing Enterobacteriaceae are considered as the most important factor for developing resistance towards the antibiotics like penicillins and cephalosporins which favours plasmid mediating resistance. MBL is the class B type of beta-lactamase which mediates the resistance towards carbapenems among *Pseudomonas* spp. which causes severe septicemia and pneumonia. The rate of morbidity and mortality associated with MRSA infection is reported to be high due to its virulence and high rate of relapse [6-11].

In general, treating ESBL, AmpC, MBL and MRSA associated implant infections using commonly prescribed antibiotics results in treatment failure which also increases morbidity. In this context, the study was conducted to monitor the antimicrobial resistance pattern, incidence of ESBL, AmpC, MRSA and MBL isolates from the infected orthopaedic implant cases at Karnataka Institute of Medical Sciences Hospital (KIMS), Hubli, Karnataka, India.

MATERIALS AND METHODS

The present study was a prospective observational study conducted over one year (February 2015 and February 2016) among the patients who had undergone various orthopaedic implant surgeries in the Orthopaedic Department, KIMS after obtaining consent from patients and clearance from the Ethical Committee (PGS/515/2014-15). As it was time-bound study, A number was restricted to 200 patients. Types of the implants used were recorded for further analysis.

Inclusion and Exclusion criteria: The patient who underwent surgery (in KIMS, Hubli) related to any orthopaedic trauma, who later developed purulent discharge with the signs and symptoms of fever along with significant rise in total leucocyte counts, post surgery with culture positivity or any sign of inflammation with gaping of incision site were included in the study. Patients admitted with implant infections (operated elsewhere) and implant surgeries done in place other than KIMS were excluded from the study.

Sample collection: Aspirates/swabs were collected from the site of surgery under all aseptic precautions to avoid contamination and were immediately transported to the Department for culture and antibiotic sensitivity testing.

Processing of the samples: Swabs were inoculated onto Blood agar and MacConkey agar and incubated at 37ºC for 18-24 hours. The isolates were identified by phenotypic and biochemical reactions. For Staphylococcal isolates, coagulase test was used to differentiate *S. aureus* and CoNS. Antimicrobial susceptibility testing was done by Kirby-Bauer disc diffusion method as per Clinical and Laboratory Standards Institute (CLSI) guidelines [12].

Detection of ESBL and AmpC

All *E.coli*, *Klebsiella* spp., *Proteus* spp., *Citrobacter* spp., non fermenting gram negative bacilli, and *Providencia* spp. which were screened for ESBL production by using ceftazidime (30 µg) disc. Isolates with ceftazidime zone of ≤17 mm were considered as positives for ESBL production [13].Those isolates showed screening test positive for ESBL production subjected to phenotypic confirmatory tests by using ceftazidime disc (30 µg) alone and in combination with clavulanate (10 µg) were used for confirmation of ESBL production. A difference of ≥5 mm between the zone diameters of ceftazidime disk and the ceftazidime-clavulanate combination disc was taken to be confirmatory for ESBL production. Similarly, AmpC production was screened by using cefoxitin disk (30 µg). Isolates with cefoxitin zone of ≤18 mm were considered as positives for AmpC production [13].

Detection of MBL

The *P.aeruginosa* isolates were screened for detection of MBL producers by using imipenem disc alone and combined disc diffusion method using discs containing 10 µg of imipenem with and without EDTA (930 µg) on Muller Hinton Agar (MHA) plate. If the zone of inhibition was less than 19 mm, it was considered as a positive screening test for MBL. MBL production was inferred if the inhibition zone increases by 5 mm towards the disk containing EDTA in comparison to imipenem disk alone [14].

Detection of MRSA

Among Staphylococcal isolates, screening for MRSA detection was done by using 30 µg of cefoxitin disk on MHA. The isolates were considered as methicillin-resistant if the zone of inhibition ≤21 mm [15].

STATISTICAL ANALYSIS

The results were analysed using the Chi-square test, Fisher's exact test and test of proportions, wherever applicable. The difference in proportion was considered if p-value was <0.05. The analysis was performed using SPSS software version 20.0 Chicago, USA.

RESULTS

Among 200 samples, majority of the patients belonged to the age group 30-39 years (27%) followed by 20-29 years (23.5%). Male (84.5%) proportionate was high when compared to female (15.5%) with ratio 5.4:1. Among 200 samples, monomicrobial isolates obtained in 190 (95%) and polymicrobial isolate obtained in 10 (5%) of samples with ratio 19:1. Gram negative isolates (51.4%) were marginally higher than gram positive (48.6%) isolates. Predominant isolate was *S. aureus* (38.6%) followed by *Klebsiella* spp. (13.3%) and *P. aeruginosa* (11%). Among gram negative isolates, majority (70.4%) of the isolates were either ESBL and/or AmpC producers [Table/Fig-1].

Isolate	Number	Percentage (%)
S. aureus	81	38.6
P. aeruginosa	23	11
CoNS	21	10.0
Klebsiella pneumonia	21	10.0
NFGNB	21	10.0
E.coli	11	5.2
Citrobacter koseri	12	5.7
Klebsiella oxytoca	07	3.3
Proteus mirabilis	05	2.4
Citrobacter freundii	04	1.9
Providencia rettgeri	04	1.9
Total	210	100.0

[Table/Fig-1]: Distribution of the isolates (n=210).
Polymicrobial isolates also obtained. So, the count of isolate obtained in sample was higher than sample taken; NFGNB: Non fermenting gram negative bacilli

Among Gram negative isolates, majority of the isolates (44.4%) were ESBL and AmpC co-producers. There were no MBL producing isolates. Among ESBL and AmpC Co-producers, majority of the isolates were *Klebsiella* spp. followed by NFGNB. Among ESBL producers, majority of the isolates were *Klebsiella* spp. [Table/Fig-2].

ESBL/AmpC/ MBL	Number	Percentage (%)
ESBL and AmpC co-producers	48	44.4
ESBL producers alone	23	21.3
AmpC producers alone	05	4.6
Neither ESBL nor AmpC producers	32	29.7
Metallo beta lactamase producers	0	0.0
Total	108	100.0

[Table/Fig-2]: Distribution of resistance enzyme producers, n=108.

Most commonly used implants were intramedullary interlocking nail (65.7%) followed by dynamic compression plates (11%) and anatomical plates (8.6%). Among Gram positive isolates, majority of the isolates were MRSA (56.8%) followed by MSSA (43.2%). Among CoNS isolates (21), majority of the isolates were MRCoNS (78.6%) followed by 21.4% of MSCoNS [Table/Fig-3].

Among gram negative isolates (other than *Pseudomonas*), resistance rate was found to be more pronounced in ampicillin, 1st, 2nd, and 3rd generation cephalosporins, aminoglycosides and cotrimoxazole. The result value was statistically significant to ampicillin, ciprofloxacin and piperacillin-tazobactam [Table/Fig-4].

Implants	*E.coli*	*Klebsiella* spp.	*Citrobacter* spp.	NFGNB	*P.mirabilis*	*P. rettgeri.*	*P.aeruginosa*	*S.aureus*	CoNS	Total (%)
IM.IL nail	7	21	10	15	5	2	12	51	15	138 (65.7)
DCP plating and screwing	1	3	2	4	-	-	3	5	5	23 (11)
Anatomical plates	2	1	1	-	-	-	3	10	1	18 (8.6)
PFN with DHS	1	2	-	1	-	2	2	4	-	12 (5.7)
TBW/K wire	-	1	1	-	-	-	1	6	-	9 (4.3)
Austin-Moore Prosthesis	-	-	1	-	-	-	-	-	-	1 (0.5)
Ellis plate	-	-	1	-	-	-	2	4	-	7 (3.3)
Calcaneal plate/Kwire	-	-	-	1	-	-	-	-	-	1 (0.5)
Steinmann's pin	-	-	-	-	-	-	-	1	-	1 (0.5)
Total	11	28	16	21	5	4	23	81	21	210

[Table/Fig-3]: Distribution of isolates according to various implant surgeries (n=210).
IMIL: Intramedullary interlocking nail; DCP-y: Dynamic compression plates; PFN: Proximal femoral nail; DHS: Dynamic hip screw; TBW: Tension band wiring

Antibiotics	*E.coli* R (%)	*Klebsiella* spp R (%)	*Citrobacter* spp R (%)	NFGNB R (%)	*P.mirabilis* R (%)	*P.rettgeri* R (%)	p-value (Chi-square test)	Significance
Ampicillin (Amp)	9 (11.8)	28 (36.8)	13 (17.1)	18 (23.7)	3 (3.9)	2 (2.6)	0.044	S
Cephalothin (CLT)	10 (13.2)	26 (34.2)	14 (18.4)	19 (25)	4 (5.3)	3 (3.9)	0.051	NS
Cefoxitin (CX)	10 (13.2)	23 (30.3)	14 (18.4)	19 (25)	3 (3.9)	3 (3.9)	0.052	NS
Cefotaxime (CTX)	9 (11.8)	24 (31.6)	13 (17.1)	18 (23.7)	4 (5.3)	3 (3.9)	0.11	NS
Ceftriaxone (CTR)	9 (11.8)	24 (31.6)	13 (17.1)	18 (23.7)	4 (5.3)	3 (3.9)	0.11	NS
Cefepime (CPM)	7 (9.2)	15 (19.7)	10 (13.2)	16 (21.1)	2 (2.6)	1 (1.3)	0.066	NS
Ciprofloxacin (CIP)	7 (9.2)	7 (9.2)	4 (5.3)	10 (13.2)	1 (1.3)	0 (0.0)	0.04	S
Levofloxacin (LEV)	1 (1.3)	3 (3.9)	1 (1.3)	3 (3.9)	1 (1.3)	0 (0.0)	0.27	NS
Amoxy- clavulanic acid (AMC)	9 (11.8)	24 (31.6)	13 (17.1)	18 (23.1)	4 (5.3)	0 (0.0)	0.053	NS
Gentamycin (GEN)	5 (6.6)	13 (17.1)	10 (13.2)	14 (18.4)	4 (5.3)	2 (2.6)	0.42	NS
Amikacin (AK)	3 (3.9)	5 (6.6)	8 (10.5)	8 (10.5)	4 (5.3)	1 (1.3)	0.29	NS
Aztreonem (Az)	9 (11.8)	24 (31.6)	13 (17.1)	18 (23.1)	4 (5.3)	3 (3.9)	0.06	NS
Imipenem (IPM)	1 (1.3)	1 (1.3)	1 (1.3)	3 (3.9)	0 (0.0)	0 (0.0)	0.26	NS
Colistin (CL)	3 (3.9)	4 (5.3)	4 (5.3)	5 (6.6)	1 (1.3)	0 (0.0)	0.26	NS
CoTrimoxazole (COT)	9 (11.8)	22 (28.9)	12 (15.8)	18 (23.1)	3 (3.9)	3 (3.9)	0.055	NS
Piperacillin+Tazobactam	3 (3.9)	5 (6.6)	2 (2.6)	4 (5.3)	1 (1.3)	0 (0.0)	0.01	S

[Table/Fig-4]: Percentage resistance to antibiotics among GNBs other than *P. aeruginosa* isolates (n=76).
S: Significant; NS: Non significant

Among Pseudomonal isolates all were MBL non producers. Resistance rate was found to be more pronounced in ceftazidime, aminoglycosides, and cefaperazone. The result value was statistically significant to all antibiotics except ceftazidime, cefaperazone, gentamycin, and amikacin [Table/Fig-5].

Antibiotics	*P. aeruginosa* Sensitive No	Sensitive %	Resistant No	Resistant %	p-value (Fisher Exact)	Significance
Piperacillin	23	100	0	0.0	0.001	S
Ceftazidime	10	43.5	13	56.5	0.45	NS
Cefaperazone	13	56.5	10	43.5	0.23	NS
Cefepime	20	86.9	3	13.1	0.02	S
Ciprofloxacin	19	82.6	4	17.4	0.02	S
Levofloxacin	19	82.6	4	17.4	0.02	S
Gentamycin	11	47.8	12	52.2	0.66	NS
Amikacin	11	47.8	12	52.2	0.66	NS
Imipenem	23	100	0	0.0	0.001	S
Aztreonam	23	100	0	0.0	0.001	S
Colistin	23	100	0	0.0	0.001	S
Piperacillin+Tazobactam	23	100	0	0.0	0.001	S

[Table/Fig-5]: Antimicrobial testing for *P. aeruginosa* (n=23).

The MRSA were found to show higher rates of resistance when compared to MSSA isolates. The resistance rate was found to be more pronounced in the beta lactam antibiotics like ampicillin and amoxy-clavulanic acid and co-trimoxazole. All MRSA isolates were found to be sensitive to vancomycin and teicoplanin. The result value was statistically significant to all antibiotics [Table/Fig-6].

The MRCoNS were found to show higher rates of resistance when compared to MSCoNS. This was found to be more pronounced in the beta lactam antibiotics like ampicillin and amoxy-clavulanic acid and erythromycin. All CoNS isolates were found to be sensitive to vancomycin and teicoplanin. The result value was statistically significant to ampicillin, cefoxitin, cefepime, amoxy-clavulanic acid and cotrimoxazole [Table/Fig-7].

Implant failure: Implant failure was observed in 28 cases, most commonly observed in intramedullary interlocking nail (25 cases) followed by dynamic compression plate (3 cases). Majority of the

Resistance to antibiotics	*S. aureus* MSSA (n=35) Number	MSSA (n=35) Percentage (%)	MRSA (n=46) Number	MRSA (n=46) Percentage (%)	χ^2	p-value (Fisher exact)	Significance
Ampicillin (Amp)	32	91.4	46	100	74.1	<0.001	S
Cefoxitin (CX)	0	0	46	100	76.4	<0.001	S
Ciprofloxacin (Cip)	12	34.3	25	54.3	34.7	<0.001	S
Levofloxacin (LE)	3	8.6	5	10.9	4	0.04	S
Cefepime (CPM)	7	20	30	65.2	44	<0.001	S
Amoxy-clavulanic acid (AMC)	0	0	46	100	68.8	<0.001	S
Erythromycin (E)	9	25.7	35	76.1	18.3	<0.001	S
Clindamycin (Cd)	5	14.3	36	78.3	27.2	<0.001	S
Vancomycin (VA)	0	0	0	0	0	0	-
Linezolid (LZ)	2	5.7	6	13	4.8	0.02	S
Teicoplanin (Tei)	0	0	0	0	0	0	-
Co-trimoxazole (Cot)	20	57.1	37	80.4	35	<0.001	S
Gentamycin (Gen)	11	31.4	20	43.4	15.3	<0.001	S
Amikacin (AK)	6	17.1	10	21.7	7.6	0.006	S

[Table/Fig-6]: Percentage resistance to antibiotics among MSSA and MRSA (n=81).

Resistance to antibiotics	Coagulase negative *Staphylococcus*				χ^2	p-value (Fisher exact)	Significance
	MRCoNS (n=17)		MSCoNS (n=4)				
	Number	Percentage (%)	Number	Percentage (%)			
Ampicillin (Amp)	17	100	3	75	12.8	0.001	S
Cefoxitin (CX)	17	100	0	0	15.6	<0.001	S
Ciprofloxacin (Cip)	11	64.7	2	50	2.5	0.11	NS
Levofloxacin (LE)	9	52.3	1	25	0.84	0.99	NS
Cefepime (CPM)	10	58.8	1	25	4	0.04	S
Amoxy-clavulanic acid (AMC)	17	100	0	0	15.6	<0.001	S
Erythromycin (E)	12	70.6	2	50	1.9	0.16	NS
Clindamycin(Cd)	7	41.2	1	25	1.5	0.33	NS
Vancomycin (VA)	0	0	0	0	0	0	-
Linezolid (LZ)	6	35.3	1	25	0.84	0.35	NS
Teicoplanin (Tei)	0	0	0	0	0	0	-
Co-trimoxazole (Cot)	12	70.6	2	50.0	7.2	0.007	S
Gentamycin (Gen)	9	52.3	2	50.0	0.02	0.86	NS
Amikacin (AK)	6	35.3	1	25.0	0.22	0.63	NS

[Table/Fig-7]: Percentage resistance to antibiotics among MSCoNS and MRCoNS (n=21).

implant failure caused by gram positive isolates (19 cases) followed by gram negative isolates (9 cases). Among gram positive, majority of the implant failure was observed in MRSA (12 cases). Among gram negative, majority of the implant failure was observed in ESBL and AmpC co-producing isolates (6 cases).

DISCUSSION

Despite strict aseptic techniques and infection control practices, implant associated infections are common. Orthopaedic implant associated infections emerge as an imperative patient safety problem, as it increases the financial and societal cost of the patients [5,7,16]. Hence in this prospective observational study, the incidence of ESBL/AmpC/MBL/MRSA producing isolates from the patients who have undergone various orthopaedic implant surgeries in KIMS, Hubballi was studied.

In the present study, aerobic gram negative and gram positive isolates accounted for about 51.4% and 48.6% respectively and *S. aureus* showed predominance of about 38.5%. Similarly Khosravi AD et al. and Anisha F et al., studies agree with the present study, where they reported that *S. aureus* as the most prevalent isolate followed by *P. aeruginosa* and *Klebsiella* spp. [17,18]. The predominance of *S. aureus* was also reported by Finelli CA et al., [19] and confirmed in the review study conducted by Li B and Webster TJ [20]. In screening ESBL and/ or AmpC producing isolates, *Klebsiella* spp. which accounted for 6.7% followed by *E.coli, P.mirabilis* and NFGNB, which accounted for 1.3% each document in the present study was correlating with results of Juan C et al., [21] whereas, Kochhal N et al., [22] reported *E.coli* and *K.pneumonia* were accounted for the infection. In phenotyping ESBL and AmpC producers, ESBL and AmpC co-producers which accounted for 44.4% in the present study whereas, Linares L et al., [23] reported the incidence of ESBL and AmpC co-producers was 11.8%. Similarly, Juan C et al., [21] also reported less prevalence of ESBL and AmpC co-producers (1.6%). The percentage prevalence of ESBL and AmpC producing isolates was found to be high in the present study. These organisms show resistance towards 1st, 2nd and 3rd generation cephalosporins, ampicillin, co-trimoxazole and aminoglycosides. Imipenem and piperacillin+tazobactam were found to be an effective antibiotic in ESBL and/or AmpC producers.

About 23 (32.4%) of isolates were confirmed phenotypically as ESBL producers using ceftazidime and ceftazidme with clavulanic acid discs. Earlier reports confirm that the high-level expression of AmpC may prevent recognition of an ESBL. This problem is more common in tests with species or strains that produce a chromosomally encoded inducible AmpC β-lactamase. Similarly, for screening AmpC producers, the present study used cefoxitin disk, this results of cefoxitin screening was reported to be better when compared to study done by Singhal S et al., [24]

In the present study, the sensitivity rates of ESBL and AmpC producing organism was highest with imipenem and next was piperacillin + tazobactam. However, ESBL and AmpC producing organisms exhibited higher rates of resistance to imipenem and piperacillin + tazobactam when compared to non ESBL and non AmpC producers. The majority of ESBL and AmpC producing isolates were found to exhibit high rates of resistance to commonly used antibiotics. Specifically, high rates of resistance was observed towards penicillins, cephalosporins, and aminoglycosides. The resistance towards fluoroquinolones are most worrisome, as these drugs are most widely used.

S. aureus was considered as one among the principal causative agents of pathogens in orthopaedic implant infections which causes septic arthritis and osteomyelitis, which leads to the destruction of joint and bone. The MRSA producing isolates infecting the patients following orthopaedic implant surgeries were found to be 56.8% in the present study, whereas the prevalence of MRSA was reported to be 54.8% [25], 30.8% [26], 55% [27] and 12.7% [18]. In yet another study, MRSA was reported as the leading pathogen which accounts for about 57.3% [28]. The percentage prevalence of MRSA of the present study was coinciding. The resistance pattern of MRSA in the present study showed considerable variations with the resistance rates of previous studies [15, 25-27]. The present study, the resistance rates of MRCoNS producing isolates was highest with ampicillin, cefoxitin and amoxy-clavulanic acid. The resistance rates of MSCoNS producing isolates was highest with ampicillin. The resistance rate was more pronounced in cotrimoxazole, macrolides followed by aminoglycosides.

Similarly, the *P. aeruginosa* isolated in the present study were MBL-non producers which account for about 21.3%. This result agrees with the result of Anisha F et al., [18]. Similarly, various authors reported the prevalence of *P. aeruginosa* which varies from 30.2% [29], 34.9% [30], 20.8% [31] respectively. Even though all pseudomonal isolates were MBL-non producers, it was found to exhibit resistance to commonly used antibiotics. The resistance rate was more pronounced in ceftazidime and aminoglycosides. Various phenotypic and genetic mechanism mediates resistance in *P. aeruginosa* which results in increase in rate of resistance [32]. Considerable variations in sensitive and resistance rates were observed when compared to the reports of Juan C et al., [21], Hsieh PH et al., [30], Aggarwal AC et al., [33], and Anisha F et al., [18]. Study done by Aggarwal AC et al., [33] on antimicrobial resistance shown by MBL non producing *P. aeruginosa* isolates to Cefaperazone was 58.6%, in the present study which accounted for 43.5%.

Altogether, the total numbers of implant failures observed in the present study were 28 cases. Majority of the implant failures were observed with gram positive isolates. Among gram positive isolates, majority 12 were MRSA. Most common implant failures were observed in intramedullary interlocking nail 25 (89.2%) and dynamic compression plate 3 (10.8%). Among gram negative isolates, majority 6 (66.7%) were ESBL and AmpC co-producers. The locally conceded immune response makes implant site highly susceptible to infection [32].This results in bleeding, postoperative infection, rejection and finally in device failure [34].

Limitation(s)

Genotyping of isolates and the antibiotic resistance markers prevail among the isolates was not performed in this study due to time constrain. Molecular level characterisation of antibiotic resistance among the isolates helps us in understanding the mechanism of development of resistance among the pathogens.

CONCLUSION(S)

High rates of ESBL, AmpC and MRSA infections associated with implant surgeries indicate the necessity to formulate antibiotic policies and control measures. ESBL and AmpC producing strains were found to show higher rates of resistance to various classes of antibiotics when compared to non ESBL and non AmpC producers. MRSA isolates were found to show higher rates of resistance to various classes of antibiotics when compared to MSSA. The orthopaedic device related infections cause a lot of strain on the health services and the economy of the society, which necessitates further studies to determine the causative microorganisms, their antibiotic susceptibilities, and the associated risk factors, to initiate timely and effective preventive measure or an appropriate and aggressive treatment, for reducing the costs and for improving the quality of life. However, larger studies with bigger sample sizes are required to attain these goals.

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