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ORIGINAL ARTICLE

Microbiology of post-operative wound infection in implant surgery

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Abstract
Background: Open reduction and internal fixation (ORIF) of fractures with implants and prosthesis has become the first line in the management of fractures in most trauma centres. Incidentally, this is associated with post-operative wound infection which is accompanied by significant morbidity, cost and mortality. The objective of this paper was to identify the pattern of the bacteriological isolates responsible and their antimicrobial sensitivity
Method: We prospectively studied two hundred and fifty-four patients who had ORIF with implants and prosthesis that fulfilled a set of inclusion criteria. Post-operative wound infection was diagnosed based on the criteria of the National Research Council and follow-up was for twelve weeks. Aerobic and anaerobic cultures were carried out on each specimen.
Results: Two hundred and fifty-four patients were recruited and 19 had post-operative wound infection. The infection rate was 7.5%.Plates and screws were the commonest implant. Thirty-six bacterial isolates were recovered. Staphylococcus aureus was the commonest in 16 cases (44%), Bacteroides fragilis 4(11%), Escherichia coli 4(11%), Proteus spp.4 (11%).Others were Pseudomonas spp, Klebsiella spp. and Peptostreptococcus. Cephalosporins were found to be the most potent against Staphylococcus aureus while the anaerobes responded favourably to metronidazole.
Conclusion: Staphylococcus aureus remains the most important microorganism responsible for POWI in implants and prosthesis. Resistant strains have emerged and previously reserved drugs have become first line. Anaerobic organisms remain important isolates were such are feasible. Metronidazole should be a component of the antibiotic regimen where such cultures are not feasible.

Key words: Implants, post-operative wound infection, staphylococcus aureus, metronidazole

Introduction

Open reduction and internal fixation (ORIF) of fractures with implants and prosthesis has become the predominant modality of treatment of fractures in most trauma centres. [1] This is not only because of the better understanding of the biomechanics of implantable materials but more importantly because of the better functional outcome in these patients. [1, 2]

Incidentally, this is associated with post-operative wound infection (POWI) reported to be in the range of 0.8 to 13%[3,-7] for both deep and superficial infections with attendant morbidity and cost. This category of patients is particularly vulnerable because ORIF interferes with the blood supply to the bones and implants are foreign bodies, which provide surfaces for bacterial adherence. [2]

The microbiology of POWI in all surgical services has changed very little over the years. [4-13] Staphylococcus *aureus* is the single most commonly encountered organism. Others included aerobic gram negative organisms such as *Escherichia Coli*, *Pseudomonas* species, *Proteus* species and *Enterococcus*. The relative rates of each vary from one hospital study to another. [4-7, 9, 14, 15]

In Nigeria, Mbamali observed that 60% of his patients who had implant infection were infected by *Staphylococcus aureus.* Other organisms in that study were *Pseudomonas pyocyanea* and *Klebsiella* species. Onche[4] in Lagos cultured S*taphylococcus aureus* in 72% of cases of POWI in implants while *Escherichia coli* and *Klebsiella* species accounted for 14% each. In Jos, North Central Nigeria, the picture was slightly different where Oguachuba[16] found that in 41.9% of his wounds, *Proteus* species were cultured while *Staphylococcus aureus* was 25.6%. Coliforms (13.9%), S*treptococcus* Spp., *Pseudomonas* spp and *Klebsiella* were the other isolates. In this particular study all POWI were considered and not specifically in implant infections.

The pattern of bacteriological isolates in developed countries is slightly different from that found in Nigeria. [5,7,8] Classen et al[7] at Salt Lake City in USA reported that of the 43 bacterial isolates from clean surgical wounds including Orthopaedics, *Staphylococcus aureus* was isolated in seven cases (16.3%); gram negative rods in six(14%); *Enterobacter cloaca in* five(11.6%); *Enterococcus in* five(11.6%) and *Klebsiella pneumonia in* two (4.6%). They also found that the anaerobe, *Bacteroides fragilis* accounted for 14% of the infections. Sanderson in Middlesex, England, found *Staphylococcus aureus* being responsible for 35% of POWI in hip implants, *staphylococcus epidermidis* 15%, Coliforms 25% while anaerobes and unnamed others accounted for 25%.

It is expedient to note that facilities for anaerobic cultures are not readily available in Nigeria; hence this was not mentioned in Nigeria literatures. Fifty percent of infections presented in the first week with 90% manifesting by the end of the second week. [17] Meakins[13] and Garibaldi[18] found in their study that patient with remote site infections from the incision wounds often become infected with the same organisms. No similar studies have been documented in Nigeria in this subpopulation.

The purpose of this report was therefore to elucidate the pattern of bacteriological isolates, which are responsible for post-operative wound infections in patients who had ORIF with implants and prostheses and to identify their antimicrobial sensitivity pattern in our environment.

Patients and Methods

Study centre

This was a prospective study carried out at the National Orthopaedic Hospital, Lagos, Nigeria, between August 1998 and July 2000.

Patients selection

All the patients who had close fractures of long bones treated by ORIF with normal haematological indices were recruited into the study. Patients with diabetes mellitus, obesity, carcinoma and patients on drugs such as steroids or cytotoxics were excluded. Intra-operatively, cefuroxime (Zinacef) or Ceftriaxone (Rocephin) were used for perioperative antibiotic prophylaxis.

Wound surveillance

The primary end-point of this study was twelve completed weeks following operation. Wounds were examined for infection on days three; seven, fourteen, at discharge and subsequent follow-up visits at the outpatient clinic. The criteria for the diagnosis of post-operative wound infection were those used by the National Research Council[8] of USA who defined POWI as *"the presence of pus in a wound which has either discharged spontaneously or has to be released by the removal of sutures or re-opening the incision"*. This has been found to be a very useful epidemiological tool and has been used and validated in several studies.[5, 9, 10-12] It is not only easy to adapt but readily reproducible. Any patient who developed postoperative wound infection had his/ her urine microscopy, culture and sensitivity done. None of these patients had been previously catheterized.

The documentation of isolated organisms was based on the return from the results of microscopy, culture and sensitivity. Aerobic and anaerobic cultures were carried out using blood and chocolate agar respectively on each infected wound specimen. Anaerobic cultures could not be done at the study centre for logistic reasons. This was done at Medilab laboratories, Ebute Metta, Lagos, Nigeria.

Results

Two hundred and fifty-four patients who had ORIF during the 24 months under review fulfilled the inclusion criteria. There were 167 males and 87 females in a ratio of 2:1. The average age was 42 (SD±15) years. All had long bone fractures with the femur as the most common in 172 patients.

Implants and prostheses

The distribution of implants and prostheses used are shown in Table 1.

Bacteriological isolates

Nineteen patients had post-operative wound infections. The infection rate was 7.50%. All were superficial surgical site infections and presented within 21 days of operation. No deep infection was recorded. Thirty-six bacterial isolates were recovered from the 19 infections that occurred in the study. Thirty isolates were aerobic and six were anaerobic cultures. *Staphylococcus aureus* accounted for 16 isolates, *Bacteriodes fragilis*, *Escherichia coli* and *Proteus* species were four each while *Pseudomonas* and *Klebsiella* species were three each. This is shown on Table 2.There were 15 cases of mixed infection distributed as shown on Table 3. Gram positive organisms were more frequently encountered than the gram negative with a ratio of 16:14. Six isolates were made during anaerobe cultures of the 19 infected wound specimens, *Bacterioides fragilis* accounted for four (66.7%) while *Peptostreptococcus* for two (33.7%).Twelve yielded no growth.

Of the 19 patients who had post-operative wound infections, eight had positive urine cultures with *E. coli* as the offending organism in four(50.0%) cases, *Staphylococcus aureus* in two(25.0%), *Pseudomonas* and *Proteus* one(12.5%) each. There was a mixed infection in one case with *E. coli* and *Staphylococcus aureus.*

Positive wound and urine cultures with same organisms occurred in seven (87.5%) of the eight positive urine samples. Mixed infections in both urine and wound cultures with *E. coli and Staphylococcus aureus* were observed in three and in one case, *Staphylococcus aureus* and *pseudomonas* species.

Antibiotic sensitivity

The sensitivity pattern of the isolates is as shown in Table IV; Cloxacillin which was previously active against *Staphylococcus aureus*[5] was completely resistant in this study.

Table 1: Distribution of implants and prosthesis

Implants/prosthesis	No. (%)
Plates/screws	144 (56.7)
Kuntscher nails	60 (23.6)
Austin-moore endoprosthesis	34 (13.6)
Screws	12 (4.7)
Cerclage wire	4 (1.6)

Table 2: Distribution of single bacterial isolates

Isolate	No. (%)
Staphylococcus aureus	16 (44)
Bacteroides fragilis	4 (11)
Escherichia coli	4 (11)
Proteus species	4 (11)
Pseudomonas species	3 (8.3)
Klebsiella species	3 (8.3)
Peptostreptococcus	2 (5.4)
Total	36 (100)

Table 3: Distribution of bacterial isolates in mixed infections

Isolates	No. (%)
Staph. aureus + Proteus species	3 (21.4)
Staph. aureus + Proteus species + Bacteriodes fragilis	1 (7.1)
Staph. aureus + E. Coli + Bacteroides fragilis	1 (7.1)
Staph. aureus + Klebsiella species	1 (7.1)
Staph. aureus + Pseudomonas species	3 (21.4)
Staph. aureus + Bacteroides fragilis	2 (14.3)
E. Coli + Peptospretpococcus	1 (7.1)
E. Coli + Klebsiella species	2 (14.3)

Table 4: Antibiotic sensitivity pattern of bacterial isolates

Isolate	AMP	CLO	GEN	ERY	CID	CRO	CEF	CEP	PEF	OFX
Staph. aureus	-	-	3	2	1	5	5	7	-	-
E. Coli	-	-	4	1	-	-	-	-	1	1
Pseudomonas species	-	-	3	-	1	-	-	-	1	1
Klebsiella species	-	-	2	-	-	-	-	-	-	1
Proteus species	-	-	2	-	-	-	-	-	-	1

AMP: Ampicillin, CLO: Cloxacillin, GEN: Gentamicin, ERY: Erythromycin, CID: Ciprofloxacin, CRO: Cefuroxime, CEF: Ceftriaxone, CEP: Cephalexin, PEF: Pefloxacin, OFX: Ofloxacin

Discussion

Post-operative wound infection rate in implants and prosthesis is reported to be between two and thirteen percent. [4 - 6] This makes it not only a problem to the surgeon but to all who have a stake in the care of Orthopaedic and trauma patients. It is associated with increased morbidity, cost of health care and at times catastrophic. [2]

The microbiology of post-operative wound infection in implants has changed very little over time except[2-13] for the emergence of resistant organisms. S*taphylococcus aureus* was the most commonly isolated micro-organism in this study accounting for 44%. It was similarly most common in various other reports worldwide. The relative rates however vary from centre to centre. At the National Orthopaedic Hospital Lagos, Onche[4] found it accounted for 71.4% of his isolates while in Zaria, North Central Nigeria, Mbamali[6] isolated *staphylococcus aureus* in 60% of patients while Classen et al[7] in USA noted that it occurred in 16.3% of their cases. The picture was however different at Jos where Oguachuba[16] found *Proteus spp* to be the most common isolate with a rate of 41.9% followed by *Staphylococcus aureus* with 25.6%. What is pertinent here is that at the Jos centre, the wound was unclassified.

Other important isolates in this study were *Bacteriodes fragilis, E.coli* and *Proteus species*. The culture of *Bacteroides fragilis* is important because of the difficulties associated with anaerobic cultures in this country. It must be noted that anaerobic organisms require very stringent conditions for isolation; therefore transportation of samples should be with minimal delay. This may have been responsible for the non-mention of anaerobes in studies on infection in Nigeria. [4, 6, 8]

Eight of the 19 infections had positive urine cultures with *E.Coli* being the offending organism in 50% of cases. Positive wound swab and urine with same organisms occurred in seven cases (87.5%). All were mixed infections. This reaffirms the view

expressed by Meakins[13] and Garibaldi. [18] They opined that the presence of remote site infection was associated with increased incidence of post-operative wound infections, most frequently becoming infected with same organisms.

Cephalosporins were found to be most potent against *Staphylococcus aureus* as 10 of 17 cultures (58.8%) responded favourably to either cefuroxime or cephalexin. The hitherto traditionally potent Cloxacillin[9] was completely resisted by it. This is because of the emergence of highly resistant strains of *Staphylococcus aureus* in hospital setting. This is not unconnected with the abuse of Ampiclox by the populace since in Nigeria; antibiotics are still sold across the counter in pharmaceutical stores and by patent medicine vendors.

The gram-negative aerobic rods like *E.Coli, Pseudomonas, Proteus* and *Klebsiella* were found to be sensitive to Gentamicin while essentially resistant to the cephalosporins tested. The anaerobes were all sensitive to Metronidazole as the wounds all healed on a regimen that included Metronidazole.

This study has highlighted three issues in the microbiology of implant wound infections. Firstly, *Staphylococcus aureus* remains the most important microorganism responsible for post-operative wound infection in implants and prostheses.

Secondly, resistant strains of organisms have emerged and previously reserved drugs have become first line in treatment of these infections.

Thirdly, anaerobic organisms remain important isolates where such cultures are feasible. Metronidazole should be a component of the antibiotic regimen where such cultures cannot be done. Finally, remote site infections should be eradicated before undertaking implant or prosthetic operations.

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