ORIGINAL ARTICLE

The Bacteriology Of Diabetic Foot Ulcers In Port Harcourt, Nigeria

* C. N. Unachukwu BSc, MBBS, FWACP, ** O. K. Obunge BSc, MD, FWACP,
* O. J. Odia MBBS, FMCP, FWACP.
Department of * Internal Medicine and ** Microbiology and Parasitology,
University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria.

ABSTRACT

Background: *Diabetic foot ulcer and/or gangrene is a common cause of morbidity and mortality in Nigeria. The lesions are usually infected and early treatment of the infection will reduce the associated problems. The study was carried out to determine the common bacteriological flora of diabetic foot ulcers in Port Harcourt. The antimicrobial sensitivity pattern of the isolates was determined to enhance possible empirical treatment.*

Methods: *Deep wound swabs were collected from 60 consecutive diabetic patients admitted with foot ulcers and/or gangrene into the medical wards of the University of Port Harcourt Teaching Hospital from January 2001 to April 2002. The bacteriological isolation and antimicrobial sensitivity tests of the isolates was carried out by standard microbiological methods.*

Results: *Aerobes and anaerobes constituted 95.4% and 4.6% of the total bacterial isolates respectively. Staphylococcus aureus was the commonest bacterial isolate; it was cultured from 32 (56.1%) of infected patients and constituted 24.4% of the total isolate. The mean bacterial isolate per patient infected was 2.3. The aerobic isolates showed significant sensitivity to ciprofloxacin (78.4%), pefloxacine (71.2%), ceftazidime (73.6%) and cefuroxime (69.6%). All the anaerobic isolates were sensitive to metronidazole and clindamycin.*

Conclusion: *Infections of diabetic foot ulcers are usually polymicrobial. From the in vitro antimicrobial susceptibility pattern of the bacterial isolates, diabetic patients presenting with foot ulcers and/or gangrene could be commenced empirically on a combination of clindamycin or metronidazole and either a fluoroquinolone (ciprofloxacin or pefloxacine) or a second or third generation cephalosporin (e.g. cefuroxime or ceftazidime).*

KEY WORDS: *Diabetic foot ulcers; Bacteriology; Antibiotics; Port Harcourt.*

Paper accepted for publication 8th March 2005

INTRODUCTION

Diabetes mellitus is the most important endocrine disease in Africa with a prevalence of 0.87-11%[1, 2]. The prevalence in Nigeria is <1 to 19% [3-5]. The morbidity and mortality of the disease are due to its complications such as diabetic ketoacidosis, foot ulcers, stroke, cardiovascular disease, nephropathy and retinopathy[6].

Diabetic foot ulcers are a common cause of morbidity and mortality in Nigeria[7]. The lesions usually result from neuropathy and are usually complicated by infections[2,8]. The infections are often polymicrobial, involving both Gram-positive, Gram-negative aerobes and anaerobes[8,9]. The empirical use of antibiotics will therefore be determined by the sensitivity pattern of the local bacteriological flora. This, if judiciously done early at presentation, will reduce the mortality and morbidity in the gravely ill patients. Thus we decided to determine the local bacteriological flora of our series of diabetic patients with foot ulcers.

MATERIALS AND METHOD

Sixty (60) consecutive diabetic patients with foot ulcer and /or gangrene admitted into the medical wards of the University of Port Harcourt Teaching Hospital (UPTH) between January 2001 and April 2002 were recruited into the study. Patients with foot ulcers resulting from major trauma like road traffic accidents, malignancies and haemoglobinopathies were excluded from the study.

The demographic features of the patients were documented. Deep wound swabs were collected from the most active site of the ulcers (within the first 24 hours of hospitalization) after cleaning the ulcers with saline-soaked guaze and debridement. Two sets of specimen were collected from each site and promptly sent to

Correspondence to: Dr. C. N. Unachukwu

the microbiology laboratory. The specimens were processed by standard microbiological procedure [10] using blood agar, Mac-conkey agar, neomycin-blood agar and Robertson's cooked meat broth. Anaerobic cultures were carried out in anaerobic jars containing oxoid gas generating kits. Adequate anaerobic environment was further confirmed by failure of growth of pure isolates of the strict aerobe, *Pseudomonas aeruginosa.* The isolates were identified by standard microbiological methods[10,11]. Antimicrobial susceptibility pattern of the isolates were carried out by disc diffusion technique [10,12] using oxoid diagnostic sensitivity test agar. Discs of available, cost-effective and varying antimicrobial classes were used. Control strains of *Escherichia coli* (National Collection type culture) NCTC 10418 and *Staphylococcus aureus* NCTC 6571 were used for standardization of the susceptibility reading for Gram-negative and Gram-positive organisms respectively. Results of the antimicrobial susceptibility of the different isolates were documented.

The results obtained from the study were analyzed using the Epi Info (version 6.02, January 2001) statistical software. Mean, mode, standard deviation analysis of variance, tables and figures were used where appropriate.

RESULTS

Out of 827 medical admissions during the period of study, 315 had diabetes and related complications, 60 of which had foot ulcers and/or gangrene. The prevalence of diabetic foot ulcer and/ or gangrene among medical and diabetic admissions was therefore 7.3% and 19.0% respectively.

The mean age of the patients with diabetic foot ulcers was 54.60 14.73 years with a range of 18 86 years. There were 38(63.3%) males and 22(36.7%) females with a male: female ratio of 1.7:1. The mean duration of diabetes was 8.63 6.40 years, while the duration of ulcer before the patients presented to hospital ranged from < 1 to >19 weeks. (mean 5.75 3 weeks). The mean fasting blood glucose at presentation was 16.01 6.93 mmol/l.

Wound swabs from 57 (95.0%) of the 60 patients yielded bacterial growth while 3 (5.0%) yielded no growth. The total number of bacteria isolated from the patients was 131 with an average of 2.3 organisms per patient infected. Aerobes contributed 95.4% of the total bacterial isolates while anaerobes constituted 4.6%. Aerobes only and mixed growth of aerobes and anaerobes were isolated from 51 (89.5%) and 6 (10.5%) of the infected patients respectively. All the anaerobic cultures yielded three or more different bacteria. The anaerobes were isolated from patients with very severe ulcers/gangrene (Wagner's grade 3-5) [13] who presented after 4 weeks of onset of the lesion.

Table I shows that *Staphylococcus aureus* was the commonest organism and was isolated from 32 (56.1%) of the infected patients and constituted 24.4% of the total bacterial isolate.

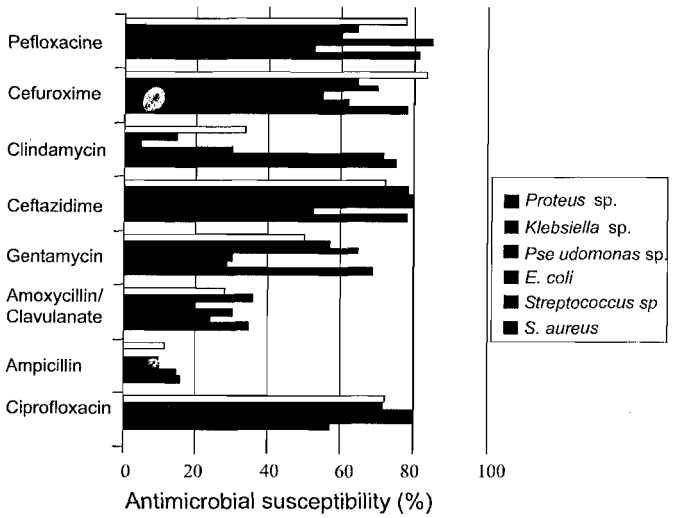
About 96.9% of the *Staphylococcus aureus* isolated was sensitive to ciprofloxacin while only 15.6% and 31.3% were sensitive to ampicillin and cloxacillin respectively. Eighty percent (80%) of *Pseudomonas* spp. were sensitive to ciprofloxacin as well as ceftazidime. The six anaerobes (all Gram-positive cocci) isolated were all sensitive to metronidazole and clindamycin. In addition to the anaerobes, 75% of *Staphylococcus aureus* and 71.5% of *Streptococcus spp.* (Gram-positive cocci) were also sensitive to clindamycin.

Figure 1 shows the susceptibility pattern of the various aerobic bacterial isolates to different antimicrobial agents.

Table I. Bacterial isolates from diabetic foot ulcers

Bacterial Isolate	No (%) of Patients infected with Isolates n = 57	% of total isolates n = 131
Staphylococcus aureus	32 (56.1)	24.4
Streptococcus spp	21 (36.8)	16.0
Escherichia coli	20 (35.1)	15.3
Pseudomonas spp	20 (35.1)	15.3
Proteus spp	18 (31.6)	13.7
Klebsiella spp	14 (2 4.6)	10.7
Anaerobes	6 (10.5)	4.6

Fig. 1. The antimicrobial susceptibility pattern of individual bacterial isolates



DISCUSSION

The polymicrobial nature of diabetic foot infections as seen in this study has been reported in various other studies [8,9,13,14]. The predominance of aerobes (95.4%) compared to anaerobes (4.6%) was very significant. Inadequacy of anaerobic facilities like gas-liquid chromatography amongst others may have contributed to the poor anaerobic yield [15]. However other workers have also reported low isolation rate of anaerobes in diabetic foot infections [16-18]. As in some other studies [8, 16, 17] *Staphylococcus aureus* was the commonest isolate probably because it is a common skin commensal and can easily infect ulcers. The co-existence of multiple aerobes with the anaerobes as seen in this study suggest possible synergism to cause progressive tissue damage [8,9].

It must be pointed out that most of the previous work on diabetic foot lesions in Nigeria[19,20] did not adequately address the role of infections especially as regards anaerobic studies. This could be due to lack of anaerobic facilities in various centres in Nigeria.

The rather high resistance of the bacterial isolates from this study to older antimicrobial agents especially the penicillins (eg ampicillin) could be due to the high rate of antibiotic abuse in this environment. In addition most penicillins are inactivated by many organisms that produce penicillinases (beta - lactamases). The beta- lactamase inhibitory property of the clavulanate in amoxicillin/clavulanate could explain its better potency when compared to other penicillins in this study. This study also revealed significant susceptibility of the isolates to relatively newer, more expensive and hence less abused antibiotics (quinolones and newer generation cephalosporins.).

Quari and Akbar[16] as well as Goldstein *et al*[17] also reported high resistance rate of many bacterial isolates from diabetic foot ulcers to commonly prescribed antibiotics. Most workers[16,17,21] identified methicillin-resistant *Staphylococcus aureus* (MRSA) as the worst offender. This study also showed high resistance rate of *Staphylococcus aureus* to penicillins. Some reports[21,22] have associated high rate of antibiotic resistance to prior exposure to antibiotics.

It is interesting to note that antibiotics of similar characteristics/class exhibited very similar sensitivity pattern, for example ciprofloxacin and pefloxacine (flouroquinolones). This finding is in keeping with the class concept of disc sensitivity[12] suggesting that the sensitivity pattern of ciprofloxacin could predict that of pefloxacine and *vice versa*.

The current flouroquinolones are especially active against Gram negative aerobic rods including *Pseudomonas aeruginosa* but not reliably active against anaerobic infections [13].

Clindamycin has been used widely in diabetic foot infections because of its excellent activity against Gram-positive bacteria and anaerobes[23]. The newer generation cephalosporins are indicated when multi-drug resistant aerobes play a role. However, additional coverage for anaerobes could be indicated[24].

In conclusion, infections of diabetic foot ulcers are usually polymicrobial. Therefore we suggest the use of antibiotics with wide coverage for aerobic as well as anaerobic bacteria. Empirical treatment should be instituted using local or environmental bacteriological studies as a guide.

For appropriate empirical treatment of

diabetic foot infections in this environment, we recommend the use of:- a flouroquinolone (ciprofloxacin or pefloxacine) with clindamycin or metronidazole; or- a second or third generation cephalosporin (cefuroxime or ceftazidime) with clindamycin or metronidazole.

The empirical antimicrobial regimen suggested from this study are among those recommended by other workers [9,13,16,17,22].

REFERENCES

1. Owosu SK. Endocrine and other metabolic diseases. In: Parry EH (ed). Principles of Medicine in Africa. 2nd Edition. Oxford: Oxford University Press, 1992: 952-972.
2. Mc Larty DG, Pottit C, Swai AB. Diabetes in Africa. Part 2. Practical Diabetes Digest 1992; 3: 35 - 40.
3. Akinkugbe OO. Non-communicable diseases in Nigeria. Final report of a National Survey, Federal Ministry of Health and Social services 1997.
4. Ohwovoriole AE, Kuti JA, Kabiawu SIO. Casual blood glucose levels and prevalence of undiscovered diabetes in Lagos metropolis Nigerians. Diabetes research and clinical practice 1988; 4 : 153-158.
5. Bakari AG, Onyemelukwe GC, Sani BS, Hassan SS, Aliyu TM. Prevalence of Diabetes in sub-Saharan Northern Nigeria; results of a Public screening Survey. Diabetes International 1999; 9 : 59-60.
6. Adetuyibi A. Diabetes in the Nigerian African . Review of long term complications. Trop Geogr Med 1976; 28: 155 -159.
7. Wokoma FS. Pattern of diabetic mortality in a Nigerian Teaching Hospital. Int Diabetes Dig 1998; 9 : 35-36.
8. Wheat LJ, Allen SD, Henry M, *et al.* Diabetic foot infections; Bacteriological analysis. Arch Intern Med 1986; 146: 1935-1940.
9. Louie TJ, Bartlett JG, Tally FP. Aerobic and anaerobic bacteria in diabetic foot ulcers. Ann Intern med 1976; 85: 461-463.
10 Cheersbrough M. Medical Laboratory Manual for Tropical Countries.Vol.2. Oxford: Butterworth Heineman Ltd, 1991: 100-203.
11 Baron EJ, Peterson LR, Sydney SM. Methods for identification of aetiological agents of infectious diseases. In: Shanahan JF (ed). Bailey and Scott's Diagnostic Microbiology. 9th edition. St Louis, Missouri: Mosby, 1994 : 321-543.
12 Barry AL, Thornberry C. Susceptibility Tests: Diffusion Test Procedures. In: Linnette EH, Ballow A (ed). Manual of Clinical microbiology. 4th edition. Washington DC: American Society of Microbiology, 1985: 978-990.
13. Vander Meer JWM, Koopman JA, Luitterman JA. Antibiotic therapy in diabetic foot infections. Diabetic Medicine 1996; 13: 548-551.
14. Sapico FL, Canawati HN, Witte JL. Quantitative aerobic and anaerobic bacteriology of infected diabetic feet. J Clin Microbiol 1980; 12 : 413-420.
15. Allen SD, Siders JA, Maler IM. Isolation and examination of anaerobic bacteria. In : Linnette EH, Ballow A (ed). Manual of Clinical Microbiology, 4th edition. Washington DC: American Society of Microbiology, 1985: 413-433.
16 Quari FA, Akbar D. The diabetic foot : presentation and treatment experience in Jeddah, Saudi Arabia. Diabetes International 2000; 10 : 88-89.
17. Goldstein EJC, Citron DM, Nesbit CA. Diabetic foot infections, bacteriology and activity of 10 oral antimicrobial agents against bacteria isolated from consecutive cases. Diabetes care 1996; 19 : 638-641.
18. Lavery LA, Sariaya M, Ashry H, Armstrong DG Microbiology of osteomyelitis in diabetic foot infections. Journal of foot and ankle surgery 1995; 34: 61-64.
19. Akanji AO, Bella AF, Agbedana EO, Osotimehin BO, Adetuyibi A. Risk factors for the development of foot lesions in Nigerian patients with diabetes. East Afr Med J 1988; 65 : 602-607.
20. Ehusani FE, Giwa SO, Ohwovoriole AE. A retrospective survey of diabetic foot lesions in Lagos. Nig J Int Med 1999; 2 : 10-12.
21 Day MR, Armstrong DG. Factors associated with methicillin resistance in diabetic foot infection. Journal of foot and ankle surgery 1997; 36 : 322-325.
22. Jeffcoate WJ, Finch RG. The use of antibiotics in lesions of the diabetic foot: A British Perspective. In: Boulton AJM, Connor H, Cavanagh PR (eds). The foot in diabetes.2nd edition. Chichester, England: John Wiley and Sons Ltd., 1997: 211-217.
23. Klainer AS. Clindamycin in the treatment of diabetic foot infections. In: Zambrano D (ed). Clindamycin in the treatment of human infections. Hong Kong: Pharmaia and UpJohn, 1997: 11-6 -11-16.
24. Gerding DN. Foot infections in diabetic patients. The role of anaerobes. Clinical infectious disease 1995; 20 (Suppl 2): S 283-S 288.