YIELD OF PLAIN FILM RADIOGRAPH IN THE DIAGNOSIS OF OSTEOMYELITIS IN PATIENTS WITH DIABETIC FOOT IN A TERTIARY CARE HOSPITAL

Zafar Ali, Muhammad Faheem, Intekhab Alam, Muhammad Amjad Taqweem

Department of Medicine,
Postgraduate Medical Institute, Lady Reading Hospital, Peshawar

ABSTRACT

Objective: *To determine the yield of plain film radiograph (PFR) in the diagnosis of osteomyelitis in patients with diabetic foot in a tertiary care hospital.*

Material and Methods: *This hospital based non-interventional, descriptive study was conducted on 60 patients. Patients of both sexes, above the age of 12 years who were known diabetics and were clinically thought of osteomyelitis were included in the study. These patients were admitted in medical wards of Post Graduate Medical Institute, Lady Reading Hospital Peshawar, from January to December 2002. Patients were selected by non-probability convenient sampling method after obtaining an informed consent.*

Results: *Out of 60 patients, 14 (23.33%) were having type 1 Diabetes Mellitus (DM) and 46 (76.66%) patients were having type 2 DM. Age of the patients ranged from 24 to 75 years, with a mean age of 52.4 years. Twelve patients (20%) had history of trauma and 21 (35%) patients had ill-fitting shoes, as risk factors for diabetic foot. Plain film radiograph detected changes of osteomyelitis in 37 (62.57%) of patients, with a sensitivity of (77.08%) and specificity of about 75%.*

Conclusion: *Plain film radiograph yields valuable anatomical information at a lower cost. It has a reasonably good detection power and its easy availability even at primary and secondary care centers makes it the imaging of first choice in the study of diabetic foot. It could be followed by a three-phase bone scan and additional imaging as and when needed.*

Key Words: *Diabetes Mellitus, Infections, Osteomyelitis, Diabetic Foot, Plain X-Rays foot.*

INTRODUCTION

The prevalence of diabetes mellitus is growing at an alarming rate globally. This has led to the use of the term "epidemic" by the World Health Organization (WHO) for the first time in the context of a chronic disorder.[1] Currently about 135 millions patients are suffering from diabetes and the globally projected rise is about 300 millions patients by year 2025. Unfortunately the major increases of about 170% will occur in the developing countries, which paradoxically have scarcity of resources to tackle this problem. About 5-18 % of people in Pakistan are suffering from diabetes mellitus/ impaired glucose tolerance. Out of these only 36.3 % are aware of their disease and 3% have reasonably good control of diabetes.[2,3]

Diabetic foot complications are the most frequent reason for hospitalization in patients with diabetes, accounting for up to 25% of all diabetic admissions in the western world.[4] About 2.4 million individuals with diabetes develop foot lesions each year. One third to one half of these eventually develop osteomyelitis.[5]

The consequences of not diagnosing osteomyelitis promptly and correctly are amputation of the affected limb, disability and, possibly, death. Risk of amputation is 15 to 46 times greater in diabetics than in non-diabetics.[6] As a result about 54,000 amputations are done annually; with related morbidity and mortality and considerable uptake of health resources.[7] This indicates the serious medical and economic implications of osteomyelitis and the need for rapid and accurate means of diagnosis.

High degree of clinical suspicion and vigilance is necessary for early diagnosis of osteomyelitis associated with diabetic foot.[8] The diagnosis in most of the cases is not possible without imaging the bone. What required is, to diagnose osteomyelitis as early and as reliably as

possible (but without being expensive) to prevent the possible longstanding and life threatening complications.

Keeping in view the socio-economic set up of our patients and local circumstances, this study was targeted to determine the yield of plain film radiograph (PFR) in the diagnosis of osteomyelitis in patients with diabetic foot. Plain film radiograph is easily available, least expensive and simplest amongst various imaging modalities.

MATERIAL AND METHODS

This was a hospital based non-interventional, descriptive case series study. It included 60 cases of clinically suspected osteomyelitis in patients with diabetic foot admitted in Medical Wards of Post Graduate Medical Institute, Govt. Lady Reading Hospital, Peshawar, from January to December 2002.

The study included all adult patients of more than 12 years of age, irrespective of sex, with diabetic foot and clinical picture of osteomyelitis. They were further divided as type1 and type2 diabetics. Patients' selection was done by non-probability convenient sampling method. An informed consent of the patients was taken for their inclusion in the study. Patients younger than 12 years, patients with non-diabetic foot lesions and patients with cellulitis were excluded from the study.

Detailed history regarding age, sex, and socioeconomic status of the patients; the duration and treatment receiving for diabetes; other medical illnesses, hospitalization and previous amputation(s) was recorded. History of ill-fitting shoes, trauma, in-growing toenail and callosities was asked to know about risk factors.

History of intermittent claudication (pain in the muscles that is relieved by rest), rest pain, numbness, anaesthesia, was obtained for assessment of peripheral vascular disease and neuropathy.

Physical examination performed with special concentration on:

Skin and soft tissues evaluation, peripheral vascular, neurological and musculoskeletal examination and fundoscopic eye examination.

Daily fasting and postprandial blood sugar levels were done and urine sugar chart maintained. Parameters for poor control of diabetes mellitus defined as: fasting blood sugar level >126mg/dl, postprandial blood sugar level >200mg/dl, impaired wound healing and evidence of other diabetic complications were all noted.

Osteomyelitis in the diabetic foot was defined as:

i.   Patients with diabetic foot with a purulent discharge, and two or more of these: warmth, erythema, oedema and raised erythrocyte sedimentation rate (ESR).

ii. The ability of probing to bone, using a sterile blunt probe.

Radiological examination was done with plain film radiograph and the following radiological findings were considered suggestive of osteomyelitis:

- Periosteal elevation (stripping of periosteum from the cortex),

- Necrosis, and

- Sequestrum formation.

The diagnosis was confirmed by radionuclide three-phase bone scan (using Technetium 99mdp). The initial (flow or dynamic) phase, recorded immediately, and the second (blood pool) phase recorded within 510 minutes. The third (delayed) phase was recorded 24 hours later.

All information was recorded on a standard proforma. Data storage, processing and analysis were done using SPSS (a computer software).

RESULTS

Out of 60 cases included in the study, 14 (23.33%) patients were having type 1 Diabetes Mellitus (DM) and 46 (76.66%) patients were having type 2 DM. There were 6 (10%) male and 8 (13.33%) female patients in type 1 DM group and 19 (31.66%) male and 27 (45%) female patients in type 2 DM group with an overall male to female ratio of 0.7:1.

Age of the patients ranged from 24 to 75 years. In type 1 DM group 4 (28.57%) patients were of <30 years of age, 7 (50%) patients in the age range of 31-40 years and 11(78.57%) patients were of more than 40 years of age. While in type 2 DM group, there were 5 (10.86%) patients in the age range of 31-40 years and 33 (71.73%) patients were of more than 40 years of age. Majority of patients i.e. 78.75% in type 1 DM group and 71.73% in type 2 DM group were of > 40 years of age. Mean age was about 52.4 years.

TYPES OF DIABETIC FOOT INVOLVED

Type of Diabetic Foot	Type 1 DM (n = 14)	Type 2 DM (n = 46)
Neuropathic	10 (71.42%)	32 (32.60%)
Ischaemic	1 (7.14%)	5 (10.86%)
Neuro-ischaemic	3 (21.42%)	9 (19.56%)

Table 1

RELATIVE FREQUENCIES OF RADIOLOGICAL FINDINGS ON PLAIN FILM RADIOGRAPH

Radiologic Findings	Type 1 DM (n = 9)	Type 2 DM (n = 28)
Necrosis	03 (33.3%)	11 (39.28%)
Periosteal reaction	03 (33.3%)	05 (17.85%)
Complex atypical	02 (22.2%)	06 (21.42%)
Sequestrum	01(11.1%)	06 (21.42%)

Table 2

Two (14.28%) patients of type 1 DM and 10 (21.73%) patients of type 2 DM group had diabetes for 1-5 years, 5 (35.71%) patients of type 1 DM and 15 (32.60%) patients of type 2 DM group had diabetes for 6-10 years. Majority of patients i.e. 7 (50%) patients of type 1 DM and 21 (45.65%) patients of type 2 DM group had diabetes for >10 years.

Of 14 patients with type 1 DM, 3 (21.42%) patients had history of trauma, 5 (35.71%) patients had ill-fitting shoes, one (7.14%) patient had in-growing toenail, and 1 (7.14%) patient had callosities. Initial mode of injury was unknown in 4 (28.57%) patients of type 1 DM group. In type 2 DM group, 9 (19.56%) patients had history of trauma, 16 (34.18%) patients had ill-fitting shoes, 3 (6.52%) patients had in-growing toenail, 3 (6.52%) patients had callosities / cracked skin. Initial mode of injury was unknown in 15 (32.60%) patients of type 2 DM group.

Neuropathic foot was present in 10 (71.42%) patients and 32 (69.56%) patients of type 1 DM, and type 2 DM groups respectively. One (7.14%) patient of type 1 DM group and 5 (10.86%) patients of type 2 DM group had ischemic foot. Neuro-ischemic foot was present in 3 (21.42%) patients of type 1 DM group and in 9 (19.56%) patients of type 2 DM group (Table #: 1).

Nine (64.28%) patients with type 1 DM, and 28 (60.86%) patients with type 2 DM had involvement of right foot while 5 (35.71%) patients with type 1 DM, and 18 (39.13%) patients with type 2 DM had involvement of left foot (Table #: 1).

Five (35.71%) patients of type 1 DM group and 14 (30.43%) patients of type 2 DM group had retinopathy. Background retinopathy was present in 3 cases of type 1 DM group, and 5 patients of type 2 DM group while proliferative retinopathy was present in 2 cases of type 1 DM group and 9 patients of type 2 DM group.

Smoking was recorded only in men in 3 (21.42%) patients of type 1 DM group and 9 (19.56%) patients of type 2 DM group. Increased leukocyte count was noted in 5 (35.71%) patients of type 1 DM and in 19 (41.30%) patients of type 2 DM and ESR was found to be raised in 8 (57.14%) patients of type 1 DM, and in 27 (58.69%) patients of type 2 DM.

Plain film radiograph of foot detected changes of osteomyelitis in 9 (64.28%) cases of type 1 DM, and 28 (60.86%) cases of type 2 DM.

Relative frequencies of various radiographic changes of osteomyelitis are shown. (Table: 2).

Three-phase bone scan was positive in 11 (78.57%) and 37 (80.43%) patients of type 1 DM and type 2 DM respectively.

DISCUSSION

Diabetes mellitus is a syndrome with disordered metabolism and inappropriate hyperglycemia due to either an absolute or relative deficiency of insulin secretion and/or insulin resistance.[9] Osteomyelitis in the diabetic foot, as defined by Cierny and Mader, is a pyogenic

PLAIN FILM RADIOGRAPHS IN OSTEOMYELITIS IN DIABETIC FOOT[20]

Reference	Sensitivity		Specificity	
Park	161/261	62%	9/13	69%
Seldin	14/15	93%	5/10	50%
Segall	7/10	70%	7/14	50%
Keenan	27/39	69%	40/49	82%
Yuh	18/24	75%	6/9	75%
Larcos	6/14	43%	29/35	83%
Newman	7/25	28%	11/12	92%
Nigro	16/22	68%	6/18	33%
Oyen	4/7	57%	15/19	79%
Weinstein	24/46	52%	13/16	81%

Table 3

infection of the bones of the feet in a physiologically compromised host both systemically (diabetes) and locally (neuropathy and/or vasculopathy).[10]

The study included 60 patients of osteomyelitis associated with diabetic foot. We observed 23.33% patients with type 1 DM and 76.66% patients with type 2 DM, showing the high prevalence of type 2 DM as compared to type 1 DM.

There were more females (58.33%) as compared to males (41.66%). Overall male to female ratio was of 0.7:1. It reflects the increase burden of diabetes among the females. In most of the studies the disease was less common in male patients [2] and ranged from 42-46 %. The exceptions being the famous UKPDS 35 study [11] where it was 58-63% in males. An Indian study by Vijay V, et al reported 54.9% in males.[12]

Age of the diabetic patients ranged from 24 to 75 years. Majority of the patients i.e. 78.75% in type 1 DM group and 71.73% in type 2 DM group were of > 40 years of age. Mean age was about 52.4 years. These observations are comparable to other studies (mean age for males (48.2) and for females (51.46) years).[2, 13]

Most of the patients i.e., 50% patients of type 1 DM and 45.65% patients of type 2 DM group had diabetes for >10 years. The increase number of patients in this age group indicates the longer the duration of diabetes the more the complications. But in the study by Chaudhary GM, only 16.6% patients were having DM of >10 years duration and was attributed to the high mortality associated with increasing duration of DM.[2]

The most important external precipitating factor found was ill-fitting shoes (41.66%), followed by history of trauma (20%) as also noted in the study by Benotmane A et al.[14] In-growing toenail, and callosities / cracked skin was found as precipitating risk factors in 6.66% patients each. Rashid T et al, reported callosities / cracked skin occurring in about 2% of patients. [15] Initial mode of injury was unknown in 31.66% patients, with similar finding of 31 % in the study by Hashim R et al.[16]

Majority of patients i.e., 71.42% of type 1 DM and 69.56% of type 2 DM groups had neuropathic foot. Ischaemic and neuro-ischaemic foot was present in the rest of the 30% 0f patients. Boulton AJM [17] and Benotemane A et al reported neuropathic foot occurring in 84% of patients. [14] Assessment of neuropathy and ischaemia was done clinically in the present study as we are lacking the facilities of non-invasive vascular tests (transcutaneous oxygen measurement etc) and

biothesiometry, which may be the reason for occurring of ischaemic and neuro-ischaemic foot in 30% of the patients. A diabetic neuropathic wound was noted frequently on plantar surface, where as neuro-ischaemic wounds on the foot margins. It may be related to differences in pressure loading.[18]

The right foot was more commonly involved in 64.28% patients with type 1 DM and 60.86% patients with type 2 DM while 35.71% patients with type 1 DM and 39.13% patients with type 2 DM had involvement of left foot. These findings are comparable to study by Ahmad M et al, with involvement of right foot in 65.7% and left foot in 34.3% of patients. [19] Probably the right foot is more used e.g., in kicking etc.

Retinopathy was found to be present in 31.66% of patients which is comparable to 30% in the study by Hashim R et al. [16] Background retinopathy was common in type 1 diabetics while proliferative retinopathy was common in type 2 diabetics. High prevalence of retinopathy in his study may be due to poor metabolic control and presence of other associated complications of DM signifying advanced diabetes. UKPDS has shown beyond doubt that improving glycaemia in patients with type 2 diabetes reduces the risk of diabetic complications. It also reflects lack of early diagnosis with poor ocular examinations by primary care physicians.

Smoking was noticed only in men (20%). Cultural customs may be involved, as in our setup smoking is usually not observed in females. Increased leucocytes count was noted in 35.71% patients of type 1 DM, and in 41.30% patients of type 2 DM and ESR was found to be raised in 57.14% patients of type 1 DM, and in 58.69% patients of type 2 DM.

Plain film radiograph (PFR) detected changes of osteomyelitis in 64.28% cases of type 1 DM and 60.86% cases of type 2 DM (overall sensitivity of 62.57%). But comparing with the results of three- phase bone scan, which was positive in 48 (79.5%) of diabetic patients, PFR has a sensitivity of about 77.08%. In 4 patients in whom PFR detected changes of osteomyelitis, bone scan was not suggestive of osteomyelitis. Thus PFR was considered 75% specific comparing with results of three-phase bone scan. The sensitivity of PFR reported from various studies ranges from 79%- 85% and the specificity in the range of 54%-75% (Table #: 3).[20]

Three phase bone scan was positive in 78.57% and 80.43% patients of type 1 DM and type 2 DM respectively. Bone scan was found to be more sensitive than PFR.[20] False negative examinations can be caused by ischemia; the

radiotracer must be able to reach the foot to accumulate in the focus of osteomyelitis.

CONCLUSION

Plain film radiograph yields valuable anatomical information at a lower cost. It has a reasonably good detection power. It is easily available even at primary and secondary care centers. It is considered the imaging of first choice in the study of diabetic foot. It could be followed by a Three-Phase Bone Scan and additional imaging as and when needed.

REFERENCES

1. King H, Auberti RE, Herman DH. Global burden of diabetes, 1995-2025, prevalence. Diabetes Care 1998; 21: 1414-31.

2. Chaudhary GM. Demographic aspects of 3275 diabetic patients. J Coll Physicians Surg Pak 2001; 11: 294-6.

3. Shera A, Rafique G, Khawaja IA. Pakistan national diabetic survey: prevalence of glucose intolerance and associated factors in Shikarpur, Sindh province. Diabetic Med 1995; 12: 1116-21.

4. Muula A. Preventing diabetes associated morbidity and mortality in resource poor communities. Diabetes Internat 2000; 12: 47-8.

5. Bloomgarden. American Diabetes Association 60th scientific sessions, 2000: The diabetic foot. Diabetes Care 2001; 24: 946-51.

6. Lipsky BA. Diagnosis and treatment of diabetic foot infections. J Am Podiatr Med Assoc 2005; 95: 183-210.

7. Armstrong DG, Lavery LA, Walker SC. Surgical morbidity and the risk of amputation due to infected puncture wounds in diabetic versus non-diabetic adults. South Med J 1997; 90: 384-9.

8. Qari FA, Akbar D. The diabetic foot presentation and treatment experience in Jeddah, Saudi Arabia. Diabetes Internl 2000; 10: 88-9.

9. Masharani U, Karam JH. Diabetes mellitus and hypoglycaemia. In: Tierney LM, McPhee SJ, Papadakis MA, eds. Current Medical Diagnosis and Treatment. 44th ed. New York: Appleton and Lange; 2005: 1157-60.

10. Muha J. Local wound care in diabetic foot complications: aggressive risk management and ulcer treatment to avoid amputation. Postgrad Med 1999; 106: 97-102.

11. Stratton IM, Adler AL, Neil HAW. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. Br Med J 2000; 321: 405-12.

12. Vijay V, Narasimham DV, Seena R. Clinical profile of diabetic foot infections in south India: a retrospective study. Diabetic Med 2000; 17: 215-8.

13. Nambuya AP, Clim MA, Whitehead H. The presentation of newly diagnosed diabetic patients in Uganda. Q J Med 1996; 89: 705-11.

14. Benotmane A, Mohammedi F, Ayad F, Kadi K, Azzouz A. Diabetic foot lesions: etiologic and prognostic factors. Diabetes Metab 2000; 26: 113-7.

15. Rashid T, Haroon TS. Cutaneous manifestations of diabetes mellitus: a study from Lahore, Pakistan. J Pak Med Sci 1997; 13: 217-24.

16. Hashim R, Khan FA, Khan DA, Shaukat A. Prevalence of microvascular complications in diabetic patients. J Coll Physicians Surg Pak 1999; 9: 120-2.

17. Boulton AJM. Neuropathic diabetic foot ulcers. N Eng J Med 2004; 351: 48-55.

18. Pitei DL, Lord M, Foster A, Wilson S. Plantar pressures are elevated in the neuroischaemic and the neuropathic diabetic foot. Diabetes Care 1999; 22: 1966-70.

19. Ahmad M, Farough A, Rehan TM, Yousuf M, Gill KM. Wounds of heel never heal in diabetics. J Surg Pak 2001; 6: 19-22.

20. Lipman BT, Collier BD. Detection of osteomyelitis in the neuropathic foot: nuclear medicine, MRI, and conventional radiography. Clin Nucl Med 1998; 23: 77-82.

Address for Correspondence:
Dr. Zafar Ali
Junior Registrar
Medical "B" Unit,
Post Graduate Medical Institute,
Govt: Lady Reading Hospital, Peshawar