

Factors Contributing To Major And Minor Amputations Of Diabetic Foot: An Observational Study

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Abstract

Diabetes is a major cause of lower extremity amputation throughout the world, particularly in India, which is known as diabetic capital of the world⁽¹⁾. By 2025, it is estimated that India will have world's largest population of diabetics. Diabetes Mellitus is the most important cause of non-traumatic amputations worldwide. Amputations are perhaps the most feared complication of diabetes. In 2017 around 9.4% of world population had diabetes. Among these, vast majority were inhabiting in developing nations. It is projected that by the year 2030, around 10% of the human race would become diabetics. The troublesome fact is that this disease is being diagnosed more and more in the younger population of the world. Each year, over one million amputations are being performed to alleviate disease caused by diabetes. This roughly works out as one amputation in the world every 30 seconds.

Introduction

The predisposing factors that lead to amputation are diabetic neuropathy, bony deformities, inconspicuous trauma, and vascular diseases. In the presence of an ulcer, local sepsis and vascular insufficiency are major causes of amputation. The presentation of lesions greatly differ based on socio-economic status, quality of foot care and usage of footwear. It has been projected that one in six diabetics living in developed nations will develop ulceration before they die. This problem is even more menacing in developing nations. Diabetic foot not only affects the individual but also their family and the community as a whole. It causes great strain on the financial and health care infra-structure of the nation. Another cause of concern is the emergence of type 2 Diabetes in children. These cases will eventually progress to develop micro and macrovascular complications including life-threatening infections at an early age.

Around 25% of these cases will be non-healing and up to 28% will end up in amputation. Investing in a scientific foot care techniques and guidelines will be more cost effective in the long run⁽¹⁾. Amputations alter quality of life and longevity. Amputations are associated with an increased risk of re-amputation and at an increased mortality in first decade after amputation. Early diagnosis and prompt therapy is mandatory. A team approach can reduce the number of amputations. Adequate infra-structure and facilities are essential. However, ignorance on the part of the patients and also the health care provider has made this goal hard to attain.

Materials and methods

The current study was a prospective observational study that sought to identify the many factors influencing major and minor amputation in diabetic foot with an emphasis on the steps taken to prevent the disease from progressing.

The study was conducted from July 2018 to October 2019 in the Department of General Surgery, in collaboration with Department of Neurosurgery at S.C.B. Medical College and Hospital, Cuttack. Ethical clearance was taken from the Institutional Ethics Committee prior to the start of the study.

The study population included all diabetic foot cases undergoing major and minor amputations at the Department of General Surgery, S.C.B medical College & Hospital, Cuttack. Patients undergoing an amputation following a traumatic event or those who presented with a septic stump following a prior amputation were excluded from the study. The study comprised 81 patients in all, representing every age group and gender. Written informed consent was taken from all the study participants and confidentiality was maintained throughout the study.

The diagnosis of diabetes mellitus was made by measuring random blood sugar value on admission. As a protocol, patients treated in the ward with diabetic ulcer foot underwent a standardized evaluation for assessment of peripheral vascular disease and peripheral neuropathy. Sensory neuropathy was evaluated with tuning fork and Biothesiometer. Nutritional assessment was done by measuring hemoglobin and serum albumin. The diagnosis of lower extremity arterial insufficiency was judged by both clinical and non-invasive vascular studies. Clinical signs included clinical non-palpability of one or more foot pulses of the affected foot and non-invasive study included an ankle-brachial pressure index (ABPI) of <0.8. Abnormal non-invasive vascular study or suggestive clinical signs make the diagnosis of lower extremity vascular insufficiency. Wounds with frank purulence were subjected to pus culture and sensitivity. To assess the renal function, blood serum creatinine values were taken. To know the presence of osteomyelitis, X-ray of the local part was taken.

The socio-demographic details were collected by a pre-designed questionnaire. They were later entered in Microsoft Excel sheet and necessary results were drawn. The categorical data were expressed as frequency and percentage.

Observations and Results

A total of 81 patients were evaluated. Amputations were more common in the sixth decade of life (50-60 years). Men were found to undergo amputations more frequently. The majority of amputees were discovered to have had diabetes for 11 to 20 years of their lives. However, a delayed diagnosis may cause the real time to be underestimated. There were more non-smokers (42%) than smokers (58%) among the amputees. Majority of the patients or 65.4% were in the regular habit of using footwear.

Age distribution (years)	N=81
20-30	4 (4.9%)
30-40	6 (7.4%)
40-50	10 (12.3%)
50-60	26 (32.2%)
60-70	20 (24.7%)
70-80	12 (14.8%)
80-90	3 (3.7%)
Gender distribution	
Male	48 (59.5%)
Female	33 (40.5%)
Educational status	
Illiterate	14 (17.3%)
Primary school	48 (59.3%)
Secondary school	13 (16.0%)

Degree or higher	6 (7.4%)
Duration of diabetes mellitus	
<5 years	11 (13.6%)
5-10 years	25 (30.8%)
11-20 years	31 (38.3%)
>20 years	14 (17.3%)
Smoking	
Yes	34 (42%)
No	47 (58%)
Use of footwear	
Yes	53 (65.4%)
No	28 (34.6%)

Table 1. Baseline characteristics of the amputees

The various investigations carried out on the study participants are detailed in Table 2. Random blood sugar values of more than 200mg/dl were present in a significant portion of the amputees (55.6%). 82% of the responders had anaemia, defined as having less than 12 g/dl of haemoglobin. Serum creatinine was used to gauge renal function. Renal impairment was discovered in only 29.6% of the participants, denoted by serum creatinine greater than 1 mg/dl. Liver function was indicated by serum albumin. Ankle brachial pressure index (ABPI) was used to assess the arterial condition of the affected limb. Out of 81, ABPI could be performed only on 71 patients. Tuning fork testing and biothesiometry were used to assess the extent of the neuropathy. Neuropathy was seen in a major fraction (76.5%) of the individuals. Only 35.8% of individuals had developed osteomyelitic lesions. Polymicrobial infections were discovered to be the most frequent based on pus culture and sensitivity (Table 3).

RBS value on admission (mg/dl)	N=81
<110	12 (14.8%)
110-140	17 (21%)
140-200	7 (8.6%)
>200	45 (55.6%)
Hemoglobin status (g/dl)	
<8	39 (48.1%)
8-12	28 (34.6%)
>12	14 (17.3%)
Serum creatinine (mg/dl)	
<1.0	57 (70.4%)
>1.0	24 (29.6%)
Serum albumin level (g/dl)	
>3.0	13 (16%)
2-3	45 (55.6%)

<2	23 (28.4%)
ABPI (N=71)	
<0.3	12 (16.9%)
0.4-0.8	32 (45.1%)
>0.9	27 (38%)
Neuropathy status	
Present	62 (76.5%)
Absent	19 (23.5%)
Osteomyelitic changes	
Present	29 (35.8%)
Absent	52 (64.2%)

Table 2. Investigatory findings of the amputees

Pus culture	N=81
Proteus vulgaris	9 (11.1%)
Escherechia coli	15 (18.5%)
Pseudomona aeruginosa	18 (22.2%)
Staphylococcus aureus	13 (16.1%)
Polymicrobial	26 (32.1%)

Table 3. Culture and sensitivity findings

Types of amputation

Figure 1. (Left to right) Ray amputation, Transmetatarsal amputation, Chopart amputation, Syme amputation (above knee).



Discussion and conclusion

The goal of the current study was to identify the various causes that can lead to major and minor amputations in diabetic feet, with a focus on the measures that can be taken to stop the disease's progression.

The studies by Most RS et al⁽²⁾, Siitonen OI et al⁽³⁾, Armstrong DJ et al⁽⁴⁾, Group TG⁽⁵⁾, have shown increasing age and male gender are unavoidable risk factors for amputation. In our study amputations were more common in the fifth and sixth decade and there was a male preponderance of 1.46:1. Kumar⁽⁶⁾, Walters⁽⁷⁾ have found that increasing duration of the diabetes is a risk factor for amputation. In our study, majority of the patients had long duration of diabetes. In our study, 76.5% had primary schooling or lesser education. This is quite low compared to western studies. If the educational status is low, they are usually unaware of preventive steps to be taken.

Attendance of health care facilities is likely to be less frequent (Adams AS et al⁽⁸⁾). Studies by Chantelau E et al⁽⁹⁾ have found the use of footwear in diabetes mellitus prevents the development of the initial ulcer and prevents recurrence of ulcer at the same site or different site. In our study, 34.6% of subjects did not even use the foot wear at all.

Studies by Moss and colleagues⁽¹⁰⁾ found smokers of younger age were more likely to ulcerate in diabetic patients. In Wisconsin study⁽¹⁰⁾, there was a borderline significance between smoking and ulceration in diabetic patients. In our study, 42% of study subjects were smokers. In our study 54.3% had arterial insufficiency. This is in accordance with studies by Walters et al⁽⁷⁾, Kumar et al⁽⁶⁾, Boyko et al⁽¹¹⁾ and Abbott et al. Studies by Walters⁽⁷⁾, Litzelman, Kumar⁽⁶⁾, Carrington, Abbott et al, Boyko⁽¹¹⁾, Kastenbauer have found neuropathy is a risk factor for amputation in diabetic ulcer. In our study 76.5% of subjects had neuropathy detected by tuning fork test and Biothesiometer. Studies by Carrington et al⁽¹²⁾, show that strict glycemic control can prevent amputation in diabetic foot. In our study, 55.55% of subjects had a blood glucose level of more than 200mg/dl. Fernando DJS et al⁽¹³⁾, have found diabetic nephropathy is a factor for foot ulceration sometimes progresses to amputation. In our study, 29.6% had diabetic nephropathy.

Serum albumin level more than 3gms% is necessary for adequate wound healing to occur (Dickhaut SC et al⁽¹⁴⁾). In our study, 83.9% of subjects had a serum albumin level less than 3gms%. Osteomyelitis can present with the failure of the local part to heal. If there is extensive soft tissue loss, bone may be infected. Usually bone is infected by the way of blood spread. Whereas in diabetic patients, bone involvement occurs due to infection spread from without inwards i.e., from the overlying soft tissue to the deeper bone (Berendt AR⁽¹⁵⁾, Lipsky BA et al⁽¹⁶⁾). In our study 35.8% of subjects had evidence of osteomyelitic changes on imaging.

Studies by Lipsky BA et al, Borrero E, Goldstein EJ, Viswanathan V et al⁽¹⁷⁾ shows that staphylococcus aureus is the most important pathogen followed by coagulase negative staphylococcus. With optimal microbiological techniques, most of these infections are noted to be polymicrobial. In our study, 32.09% of subjects had polymicrobial infection, and 16.09% of subjects had infection with staphylococcus aureus. However, studies by Cunha BA et al⁽¹⁸⁾, have found organisms like enterococci, and pseudomonas aeruginosa, are often colonizers rather than pathogen, and antimicrobial therapy specifically targeted against them may not be required.

Steps towards prevention

The high prevalence of foot infections and the subsequent economic burden on an already strained economy, gives rise to urgent need to promote foot care in a country like India. The essential step in this goal is early diagnosis of loss protective sensation and ischemia. Surface examination of the foot to diagnose deformities, skin involvement is essential. Toe-nail should be properly taken care of. Injuries caused by toe nails, nail infections and onychocryptosis should be identified. Life-long care regarding the type of foot wear used should be exercised. The aim of footwear is prevention of ulcer formation, prevent re-ulceration and new site ulcer formation. Nearly 80% of the patients can be benefited from 'over-the-counter' sport shoes with custom-made insoles. Only patients with severe deformities require custom-molded shoes. The biomechanical goal is load reduction and weight transference.

Foot before ulcer formation requires meticulous and scientific care by self and also by the clinician. The management team members include podiatrist, internist, ophthalmologist, endocrinologist, infectious disease specialist, cardiologist, nephrologists, vascular surgeon, orthopedic surgeon, nurse (educator, wound care, and home care), pedorthist/orthotist.

Frequent education of patients and family members is essential. This includes knowledge regarding glycemic control, diet plans, proper foot wear and need for early identification of early foot lesions. Primary, secondary and tertiary levels of care are required to be imparted into the patient's knowledge so as not to burden the clinician alone with the sole responsibility of care of the patient. Health care personnel education is equally important. A recent study from Cuttack reported that of 1259 patients at previous high risk and who presented with foot ulcers, healing occurred in 82% who were judged to have adhered to foot ulcer care advice, compared to 50% of those who did not⁽¹⁹⁾. Patients should be given ample advice on glycemic control, smoking reduction, regular exercise, dietary pattern changes, use of low-dose aspirin and statin therapy.

The Himalayan psychosocial and economic costs of diabetes foot diseases can be brought down by simple

preventive measures. Though it may not be possible to completely prevent ulceration, it is definitely possible to prevent progression of small lesions to the level of amputation. The key elements of preventive care are yearly examination by health care providers to determine risk factors, examination of at-risk feet at each visit, patient awareness on daily foot care and diabetes management, establishment of specialized clinics to concentrate exclusively on diabetic patients.

60% of patients with ulcer will have recurrence of ulcer in the same region. Despite wide-spread availability of newer therapeutics and diagnostics, the effective prevention of reulceration is paramount in reducing the social and economic burden caused by diabetic foot ulcers. Therapeutic foot wear plays a key role in this context. The Achilles heel in attaining this elusive target still remains the patients lack of knowledge and non-compliance with advice of expert health-care personnel.

Amputation often becomes a palliative or life-saving procedure. Major and minor amputations in the younger age group has devastating socioeconomic consequences. Advances in prosthesis and rehabilitation can lessen this burden. Still the most cost effective methods are directed at prevention.

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