Distance as a Risk Factor for Amputation in Patients with Diabetes: A Case-Control Study

Abstract:

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Abstract

We studied the association between amputation and distance of patientsâ residences to a diabetes care centre. We performed a case-control study matching each case (amputation) with 5 controls (no amputation) by age and sex. We compared the distance of residence to the diabetes centre, duration and type of diabetes, haemoglobin-A1c levels and foot examination findings for cases and controls. We analysed the association between distance and the strongest predictors of amputation. Sixty-six cases of amputation and 313 controls were identified. Distance of residence was 12.1km greater for cases (p=0.028). In multivariate analysis, only diabetes duration (OR/year 1.07, 1.03 to 1.11) and neuropathy (OR 10.73, 4.55 to 25.74) were significantly associated with amputation. Patients with neuropathy resided 9.7km further than those without neuropathy (p=0.01). Patients requiring amputation reside at greater distances from the diabetes centre, possibly due to higher rates of neuropathy.

Introduction

Diabetes is the leading cause of lower extremity amputation.[1] Lower extremity amputation rates are often used as a marker of the quality of foot care in patients with diabetes[1]. The causative pathway leading from diabetic foot disease to amputation is well established[2]. A delay in diagnosis and appropriate management of diabetic foot disease increases morbidity and mortality, resulting in a higher amputation rate[3]. Access to expert diabetic foot care in a timely manner is vital for successful outcomes in active diabetic foot disease. University Hospital Galway (UHG) serves as a tertiary referral centre for the predominately-rural west of Ireland. In clinical practice, we observed that many patients requiring amputation reside at great distances from the tertiary referral centre. The West of Ireland Diabetic Foot Study estimated that the incidence of neuropathy, a known risk factor for amputation, is relatively high at 30% in this community[4]. Regular screening of patients with neuropathy prevents amputations[5]. Distance effects may impact on this screening, since uptake of screening for gestational diabetes was found to be significantly lower in patients living at greater distances from screening centres in the west of Ireland[6]. Historically, there was an absence of a formal multi-disciplinary screening programme and referral pathway for patients with active diabetic foot disease in this large catchment area in the west of Ireland.

Whilst patient-centred risk factors for amputation in patients with diabetes have been established[7], studies of the influence of access to foot services on amputation rates are much fewer. We examined the association between amputation and the distance of patientsâ residence to the diabetes care centre at UHG. We hypothesised that patients with diabetes who live at greater distances from the diabetes centre are at increased risk of a delay in appropriate management of diabetic foot disease, known to cause an increase in amputations. We also analysed the relationship between distance and the strongest predictors of amputation.

Methods

We performed a case-control study of patients attending the diabetes centre at UHG, which provides comprehensive specialist diabetes care to over 5,000 people with diabetes from the west of Ireland. Each clinical encounter of patients at the diabetes centre, including the findings of foot examinations, is recorded on an electronic database (Diamond from Hicom Technology). Patients who attended between 1st January 2006 and 1st June 2011 were eligible for inclusion. Cases were defined as patients with diabetes and non-traumatic lower extremity amputation. Medical notes were reviewed to validate cases. Patients with trauma or malignancy as the reason for amputation were excluded. Controls were defined as patients with diabetes without lower extremity amputation recorded as part of their foot examination. Controls were matched by age (+/- 0.5 years) and gender. Five controls were selected per case using computer-generated random number sequences.

Driving distance from the patientsâ actual place of residence to the Diabetes Centre was calculated using online mapping with Google Maps™. Location of residence was also recorded in a separate variable as Galway City, Galway County or other counties. Diabetes control was measured as mean glycosylated haemoglobin (HbA1c, %) value across all clinic visits. Type and duration of diabetes (years) and the use of insulin therapy were recorded. Smoking status was defined as current, non-smoker or ex-smoker. Vascular assessment included palpation of dorsalis pedis and posterior tibial pulses. The absence of protective sensation was determined by assessing vibration sensation with a 128Hz tuning fork and pressure sensation with a Semmes-Weinstein 5.07/10 gram monofilament. Elements of the foot examination were grouped together for analysis. The variable â absent foot pulseâ was positive if any of the four pulses were not palpable on examination. Impaired vibration sensation or abnormal monofilament examination were combined into a single variable, â impaired sensationâ .

Continuous variables were expressed as means or medians with standard deviations (SD) or inter-quartile ranges (IQR) and compared using the Student t-test test and Mann-Whitney U test. Dichotomous and nominal variables were compared using Pearsonâ s chi-squared test. Conditional Logistic regression analysis was performed using amputation as the binary outcome variable. Predictor variables were analysed using univariate and multivariate methods, with tests for interaction. Predictor variables were added to the multivariate regression model at significance levels <0.05 and removed at levels >0.1. We calculated odds ratios (OR) with 95% confidence intervals (CI). Alpha level of 0.05 was chosen. Statistical analysis was performed using PASW 18 from SPSS.

Results

The search of our database for patients with lower-extremity amputations revealed 76 cases. Ten cases were excluded leaving 66 cases in our final analysis, comprising 26 major and 40 minor amputations. Reasons for exclusion included incorrect coding of pregnant patients (4), conflicting records of amputation (3), trauma (2) and malignancy (1). Each case was matched by age and sex with 5 controls, resulting in 313 controls in total after duplicates were removed. Mean age of cases was 57.8 years, with a range from 42 to 91 years. Male patients comprised 58 of the 66 cases (87.9%). Controls had an identical age and sex profile due to matching (Table 1).

Median distance of residence from the diabetes centre was 42.4km for cases and 30.3km for controls. Cases resided on average 12.1km further from the diabetes centre (p=0.028). Type-1 diabetes was present in 16.1% of cases as opposed to 7.1% of controls (p=0.021). Insulin therapy was utilised by 74.2% of cases, compared with only 35.5% of controls (p<0.001). Mean duration of diabetes of cases was 16.8 years compared to 8.1 years for controls. Duration of diabetes was on average 8.7 years longer for cases (95% CI 5.0 to 12.4 years, p<0.001). Mean haemoglobin-A1c across all clinic visits was 7.9% for cases and 7.4% for controls, 0.5% higher on average in cases (95% CI 0.1% to 0.9%, p0.013). Any foot pulse was not palpable in 51.1% of cases compared with 16.3% of controls (p<0.001). Either vibration or monofilament sensation was abnormal in either foot in 79.6% of cases and 29.2% of controls (p=0.001).

In univariate analysis, patients with amputation lived at greater distances from the diabetes centre (OR per km 1.01, 95%CI 1.00, 1.02) and were more likely to live in counties other then Galway (OR 2.58, 95% CI 1.12, 5.98) (Table 2). Patients with amputation were also more likely to have type-1 diabetes (OR 2.51, 95% CI 1.12, 5.60), a longer duration of diabetes (OR per year 1.08, 95% CI 1.05, 1.11), higher HbA1c levels (OR per % 1.32, 95% CI 1.08, 1.61) and use insulin (OR 5.27, 95% CI 2.85, 5.95). In multivariate analysis, only duration of diabetes (OR per year 1.07, 95% CI

1.03, 1.11) and impaired sensation (OR 10.73, 95% CI 4.55, 25.74) were significantly associated with amputation. Patients with neuropathy resided 9.7km further than those without neuropathy (p=0.01). There was no significant correlation between distance and diabetes duration (r=0.13, p=0.81) or mean haemoglobin-A1c levels (r=0.04, p=0.461).

Discussion

The results of our case-control study provides evidence that patients attending the Diabetes Centre at UHG who have required foot amputation reside at greater distances from the Diabetes Centre than patients who have not required amputation, 12.1km further on average. After correction for all other factors, amputation was significantly associated with loss of protective sensation and longer duration of diabetes. In an effort to explain this association between distance and amputation, we noted that neuropathy was more likely in those living at greater distances. A delay in diagnosis and appropriate management of diabetic foot disease results in a higher amputation rate3. The distance from patientsâ residence to the specialist centre should not be interpreted as a simple surrogate marker of access to care, but our results suggest that patients requiring amputation live at greater distances from the specialist centre. Furthermore, patients requiring amputation are more than twice as likely to come from a county other than Galway, where the specialist centre is located.

The Health Service Executiveâ s National Diabetes Programme has published â Model of Care for the Diabetic Footâ , which outlines a national multidisciplinary foot care service for people with diabetes[8]. Recommendations include regular podiatry review of patients with neuropathy or vascular disease, and rapid access to multidisciplinary care in a hospital setting for all patients with active diabetic foot disease. Our results highlight the need for regular monitoring and care pathways that will allow patients with diabetic foot disease, especially neuropathy, to access the appropriate level of specialist care in a timely manner, regardless of their location.

Studies of the prevalence of diabetic foot disease in rural areas have demonstrated high rates of diabetic foot complications. A study of diabetic foot care in a rural northern Canadian Aboriginal community showed low rates of foot screening examinations and corresponding high rates of hospitalisation with diabetic foot complications[9]. Among diabetic foot patients attended by a multidisciplinary team in Ottawa, Canada, residence in a rural setting correlated with a shorter time from initial clinic visit to major lower extremity amputation[10]. Our findings add to this body of work in that patients requiring amputation live at greater distances from the specialty centre in the setting of the predominately rural west of Ireland. We did not intend to determine the incidence amputation rate for patients with diabetes in the west of Ireland and do not claim to have captured all patients with diabetes-related amputations in our catchment area. Instead, we performed this study to explore possible risks for amputation among the geographically diverse population of patients with diabetes who attend our diabetes centre.

In conclusion, our case-control study suggests that patients who required foot amputation reside at greater distances from the Diabetes Centre than patients who have not required amputation. This effect of distance is most likely manifest through the association between distance and neuropathy. National diabetic foot care policy should ensure that all patients with diabetes, especially those with neuropathy, have equal access to foot-care, irrespective of place of residence.

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