

# Incidence and location of diabetic foot ulcer recurrence

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There is currently a gap in the literature regarding the specific details of the location on the foot of recurrent diabetic foot ulcers. The authors conducted a 6-month study of people who presented with diabetic foot ulcer recurrence to a foot clinic in Malta. Data were analysed to identify any association of reulceration with age, diabetes duration, sex and previous site of ulceration. Reulceration occurred most commonly on the same foot as the previous episode of ulceration, but at a different site on the foot, suggesting the involvement of abnormal foot biomechanics.

Diabetic foot ulcers are among the most devastating of all diabetic complications at a range of levels – social, physical, psychological and economic (Levin, 2002). People with active diabetic foot ulcers experience a reduction in quality of life (Franks and Collier, 2001; Evans and Pinzur, 2005) that is reported to be as great as that of amputees (Pinzur, 2004). Diabetic foot disease is the leading cause of non-traumatic lower-limb amputation in the developed world (Jeffcoate and Harding, 2003). Furthermore, people with diabetic foot disease are a significant burden to care-givers and healthcare systems (Boulton et al, 2005).

Various international consensus statements on the management of diabetic foot disease have been developed (International Working Group on the Diabetic Foot, 2003; American Diabetes Association [ADA], 2004). One major challenge lies in the prevention of ulcer

recurrence (McInnes, 2003). Reulceration is a relatively common event, with rates of 35–40% over 3 years, increasing to 70% over 5 years (Apelqvist et al, 1993). Despite the frequency with which reulceration occurs in the diabetic foot, elements of this subject has been somewhat neglected in the literature, including the location on the foot at which the recurrent ulcer is situated.

## Literature review

Six electronic databases (CINAHL, MEDLINE, British Nursing Index, ScienceDirect, Cochrane, EBSCO) were searched for articles that made reference to the location on the foot of diabetic ulcer recurrence. Only those published in English or Maltese were included in the search. The search terms (“diabetic foot ulcer recurrence, site of diabetic foot ulcer recurrence, location of diabetic foot ulcer recurrence,

## Article points

1. Preventing diabetic foot ulcer recurrence is an on going challenge for people with diabetes and healthcare professionals.
2. There is a gap in the literature on the specific details regarding the site of foot ulcer recurrence.
3. A study of the site of ulcer recurrence was undertaken in a Maltese population.
4. The most frequent site of ulcer recurrence was found to be the same foot, but not the same site.
5. The findings implicate abnormal foot biomechanics in the pathway to reulceration.

## Keywords:

- Foot ulcer
- Reulceration site
- Ulcer recurrence

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### Page points

1. Titles and abstracts were assessed and none specifically reported the site of diabetic foot ulcer recurrence.
2. The authors conducted a 6-month study of foot reulceration at their diabetic foot clinic in Malta, seeking to identify any association between reulceration, age, diabetes duration, sex and site of previous ulceration.
3. The current study was undertaken at the diabetic foot clinic within the Diabetes and Endocrine Centre, St Luke's Hospital, G'Mangia, Malta.
4. All people with types 1 and 2 diabetes, over 18 years of age, attending the Diabetic Foot Clinic for the treatment of recurrent foot ulceration during the 6-month study period were identified for inclusion in the study.

diabetic amputations, ulcer-free survival diabetes, repetitive ulceration") yielded 128 articles. In addition, several medical and nursing journals, and relevant conference proceedings and symposia, were hand-searched but yielded no relevant material.

Titles and abstracts were assessed for any reference to ulcer site, narrowing the pool of articles to three: Mantey et al (1999), Connor and Mahdi (2004), Pound et al (2005). None of these studies on diabetic foot ulcer recurrence specifically reported the site of recurrence.

There is, therefore, a significant gap in the literature with regard to the site of diabetic foot ulcer recurrence, and such knowledge could influence management of this high-risk population.

### Aims

The authors conducted a 6-month study of foot reulceration at a diabetic foot clinic in Malta, seeking to identify any association between reulceration, age, diabetes duration, sex and site of previous ulceration.

There is a high prevalence of type 2 diabetes in the Maltese population (Savona-Ventura, 2002). Indeed, the World Health Organization (WHO) reports a type 2 diabetes prevalence of 10% for Malta – the highest prevalence of type 2 diabetes in Europe where a prevalence of 2–3% is common (Townsend Rocchiccioli et al, 2005; WHO, 2007).

### Methods

The current study was undertaken at the diabetic foot clinic within the Diabetes and Endocrine Centre, St Luke's Hospital, G'Mangia, Malta. Since completion of the study, the St Luke's Hospital facility has been closed and the Diabetes and Endocrine Centre, and its associated clinics, relocated to the Mater Dei Hospital, Tal-Qroqq, Malta.

Patients are referred to the Diabetic Foot Clinic from the Diabetes and Endocrine Centre, from the community and from the Emergency Department. Individuals need to be referred to attend, but the clinic treats all levels of foot care from active diabetic foot ulceration to preventive care and advice.

Data from the diabetic foot clinic in 2004 show an incidence of foot ulcer recurrence of 32% (Azzopardi and Grixti, 2004), although the site of ulcer recurrence is not reported.

Ethical approval was gained from the Research Ethics Committee, University of Malta prior to commencement of the study.

### Participants

All people with type 1 or 2 diabetes, over 18 years of age, attending the clinic for the management of recurrent foot ulceration during the 6-month study period (October 2005–March 2006) were identified for inclusion in the study.

People were excluded from the study if they fulfilled any one of the following criteria:

- Unwilling or unable to follow instructions and comply with the study protocol.
- Diagnosed neurological condition (e.g. cerebral vascular accident, spina bifida, multiple sclerosis).
- Diagnosed systemic disease (e.g. rheumatoid arthritis, systemic sclerosis).
- Chronic alcohol abuse (alcoholism being a common cause of peripheral neuropathy).
- Neck, back or lower-limb trauma (due to associated sensory loss).
- Diagnosed pernicious anaemia (due to its impairment of wound healing).
- Receiving long-term steroid therapy (due to immunocompromise).

All those meeting the inclusion criteria ( $n=32$ ) were invited verbally, and in writing, to participate in the study. All 32 people invited agreed to participate (100% response rate).

### Data collection

Three sources were used to collect demographic information, and current and retrospective clinical data: an interview, a clinical examination and participants' medical records. For the purposes of comparison, demographic and ulcer site data were also recorded for people who presented to the clinic with their first ulcer during the same period.

**Participant interview**

Participants were interviewed by the first author and a clinic podiatrist. Each participant's age, sex, diabetes type and duration were recorded. Data were also collected on their previous ulcer (date, site and neuropathic/ischaemic/neuroischaemic classification) and the time in months from previous ulcer resolution to reulceration.

**Clinical examination**

Each participant was clinically assessed to provide information both on their current episode of ulceration (reulcerated) and to verify the data in their medical records on their foot ulcer history. In participants presenting with more than one ulcer, the largest ulcer was considered the most clinically significant (Jeffcoate et al, 2006) and data from that ulcer were recorded and used for analysis.

The site of reulceration was recorded for each participant as: (i) same site, same foot; (ii) different site, same foot; or (iii) other foot. Ulcers were classified as neuropathic, ischaemic or neuroischaemic.

Neuropathy was assessed using the Semmes–Weinstein 10-g monofilament (North Coast Medical, Campbell, CA). The inability to perceive a 10-g force applied at one or more site(s) was considered to be indicative of clinically significant neuropathy (Baker et al, 2005) and the ulcer was classified as neuropathic.

Ischaemia was assessed by palpation of pedal pulses and use of Doppler ultrasound where necessary. The absence of pedal pulses is associated with peripheral vascular disease (ADA, 2004) and participants with absent pedal pulses were classified as having an ischaemic ulcer.

In participants who failed to perceive a 10-g monofilament at one or more of the test site(s), and in whom pedal pulses were absent, the ulcer was classified as neuroischaemic.

**Medical histories**

Participants' medical histories were investigated to confirm the information found during participant interview, especially with regard to

the site of the previous episode of ulceration. The site of previous ulceration was recorded as for the current episode (same site, same foot; different site, same foot; other foot).

All the participants had been treated for their previous episode of ulceration at the diabetes foot clinic. Thus, all medical histories were available to the authors. The medical histories were all classified using the same investigative techniques used for the current study, and were recorded clearly.

**Results**

During the study period, 66 people presented to the authors' clinic with active diabetic foot ulceration. Of these, 32 (48.5%) were ulcer recurrences, and all of whom were included in the current study.

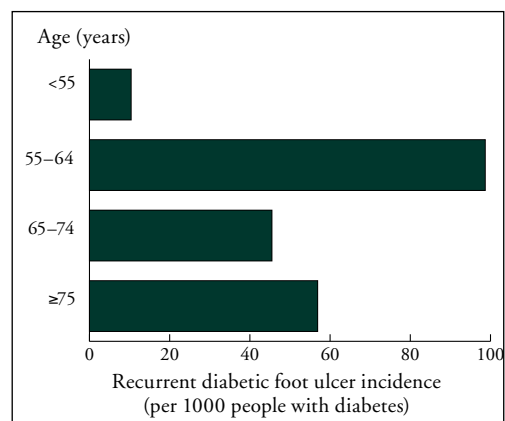
All but one (31/32, 96.9%) participant with recurrent ulceration had type 2 diabetes. Participants had, on average, a diagnosed diabetes duration of 12.5 years (range 3–32 years).

Twenty (62.5%) participants were male. The proportion of men with reulceration was not significantly different to that of men who presented during the same period for their first episode of ulceration (20/34, 58.8%).

The mean ( $\pm$  standard deviation) age of those with recurrent ulceration was  $62.3 \pm 11.1$  years. Those treated for their first episode of foot ulceration during the same period were  $66.3 \pm 13.7$  years old. The difference between the age of those with recurrent and those with their first ulcers was not significant. *Figure 1* shows the

**Page points**

1. The site of reulceration was recorded for each participant as: (i) same site, same foot; (ii) different site, same foot; or (iii) other foot.
2. During the study period, 66 people presented to the authors' clinic with active diabetic foot ulceration.
3. All but one participant with recurrent ulceration had type 2 diabetes.
4. The proportion of men with reulceration was not significantly different to that of men who presented during the same period for their first episode of ulceration.



*Figure 1. Incidence of recurrent diabetic foot ulceration by age group.*

**Page points**

1. Reulceration occurred on the same foot in 84.4% of participants, and the majority of these ulcers were on the plantar aspect of the foot.
2. A significant association was found between the site of ulceration and age ( $P=0.271$ ).
3. A non-significant trend was found that suggested a longer ulcer-free survival period for those in whom the ulcer recurred at the same site on the same foot.
4. The current study identifies the area of the foot most likely to reulcerate. The majority of recurrent ulcers were found to be located on the plantar aspect of the foot or the apex of the toes.

incidence of reulceration per 1000 people with diabetes by age group.

**Reulceration site and nature of ulcer**

Reulceration occurred on the same foot in 27 (84.4%) participants (95% confidence interval [CI] 67.2–94.7). The majority of these ulcers were on the plantar aspect of the foot (14/32, 43.8%), 10 (31.3%) were on the apex of the toes, five (15.6%) were located dorsally, and three (9.4%) on the lateral aspect of the heel. Of the 27 ulcers that recurred on the same foot, 11 (34.4%; 95% CI 18.6–53.2) recurred at the same site, on the same foot (*Table 1*).

Ulcers were mostly neuropathic (15/32, 46.9%) or neuroischaemic (10/32, 31.3%). Only 21.9% (7/32) of recurrent ulcers were ischaemic.

**Ulcer-free survival time**

The interval between the previous episode of ulceration and ulcer recurrence (ulcer-free survival time) ranged from 1–51 months, with a median of 255 days (interquartile range 69–660 days). It was found that 53.1% (17/32) of ulcers recurred within 6 months of the previous ulcer having healed, while 59.4% (19/32) recurred within 12 months.

**Analysis**

A significant association was found between the site of reulceration and age ( $P=0.271$ ). Participants aged 60–70 years ran a higher risk of ulcer recurrence at the same site on the same foot (*Figure 2*). There was a non-significant trend for reulceration to occur on the other foot within a shorter period of time than for those that recurred on the same foot at the same, or a different, site (*Figure 3*). A non-significant trend was found that suggested a longer ulcer-free survival period for those in whom the ulcer recurred

at the same site on the same foot (Log-rank test,  $P=0.11$ ). Females ran a higher risk of reulceration at a different site on the same foot than males (Chi-square test=0.331).

There was no significant correlation between ulcer-free survival and age ( $r=0.26$ ,  $P=0.15$ ), or known duration of diabetes ( $r=0.25$ ,  $P=0.17$ ).

**Discussion**

This study, for the first time, sheds light on the site of diabetic foot ulcer recurrence in Malta. The literature on diabetic foot ulcer recurrence does not provide details of the specific site of reulceration, rather it describes only the incidence. Thus, it was not possible to compare the findings with regard to site of reulceration of the present study with any historical data.

The current study identifies the area of the foot most likely to reulcerate. The majority of recurrent ulcers were found to be located on the plantar aspect of the foot or the apex of the toes. This finding suggests that people at risk of reulceration should check these high-risk sites during their recommended daily foot inspections.

The findings of the current study reveal that the 12 months following the healing of an ulcer is the most high-risk period for reulceration. During this time-window, people with a healed ulcer may need to be followed-up frequently to monitor for possible reulceration.

Ulceration commonly occurs on the plantar surface of the foot in areas of increased pressure, caused by repetitive or excessive pressure on the frequently insensate foot (van Schie, 2005). Reulceration in this population was found to have occurred most frequently on the same foot as the previous episode of ulceration, but more commonly at a different site on that foot. The authors' clinical experience suggests that people with

**Table 1. Summary of ulcer recurrence location.**

| Foot                 | Location on foot |                       | Total |
|----------------------|------------------|-----------------------|-------|
|                      | Same as previous | Different to previous |       |
| Same as previous     | 11               | 16                    | 27    |
| Opposite to previous | 5                |                       | 5     |
| <b>Total</b>         | 16               | 16                    | 32    |

diabetic foot disease attempt to walk in a manner that avoids applying pressure to a previously ulcerated site. Consequently, pressure on the foot is redistributed and another site on the same foot becomes exposed to repetitive or excessive pressure, in turn disposing that site to ulceration. This suggests that biomechanical abnormalities may be especially important in determining the site of reulceration, and that further research into the redistribution of pressure on the foot following an episode of ulceration is warranted.

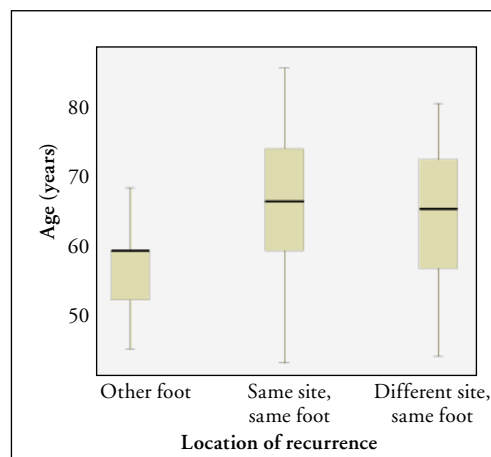
The data reported here with regard to sex, age, diabetes type and duration and reulceration are broadly consistent with the literature. The cohort included a preponderance of males, as has been reported elsewhere (Merza and Tesfaye, 2003). Here, the highest incidence of reulceration occurred in participants 55–64 years of age, a finding consistent with the literature (Reiber, 2001). A similar duration of diabetes (average 12.5 years) was found in the current cohort as has been reported elsewhere in the literature, with longer diabetes duration strongly associated with increased foot ulcer risk, as well as with neuropathy and peripheral vascular disease (Young et al, 1993; Day and Harkless, 1997; Girach et al, 2006). Here, a non-significant trend for increased duration of diabetes and reulceration was found.

Only one participant had type 1 diabetes. The over-representation of participants with type 2 diabetes is partially explained by the high prevalence of type 2 diabetes in the Maltese population (WHO, 2007). Furthermore, Mantey et al (1999) and Pound et al (2005) both concluded that people with type 1 diabetes were not at significantly more risk of foot ulcer recurrence than people with type 2 diabetes.

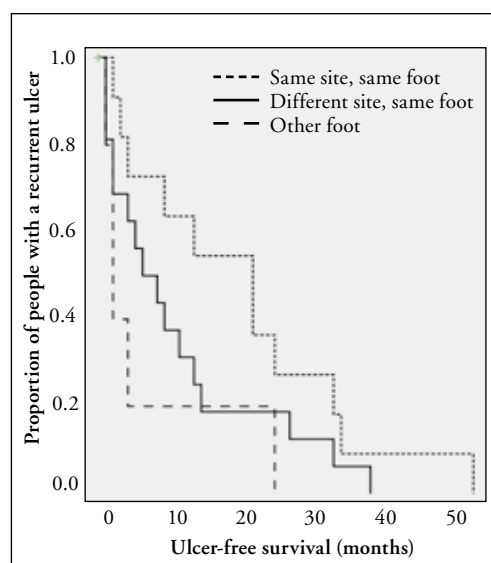
**Study limitations**

Although conducted over a reasonable length of time, the sample size used here was small. For this reason, statistical significance was not reached for a number of interactions.

*Figure 2. Recurrent ulcer location by age.*



*Figure 3. Ulcer-free survival time with respect to ulcer recurrence location.*



**Conclusion**

While the present study is limited by the size of the cohort, it contributes some data on the specific sites on the foot at which diabetic foot reulceration occurs – data notably absent from the literature. A time-window when risk of ulcer recurrence is highest was identified, during which intensive follow-up is warranted. The study also demonstrates that the most frequent site of ulcer recurrence is usually the same foot, but not the same site, and implicated abnormal foot biomechanics in this outcome.

**Page points**

1. Biomechanical abnormalities may be especially important in determining the site of reulceration.
2. The data reported here, with regard to sex, age, diabetes type and duration associated with reulceration are broadly consistent with the literature.
3. The over-representation of participants with type 2 diabetes is partially explained by the high prevalence of type 2 diabetes in the Maltese population.
4. If confirmed by other studies, the findings of this study may better direct service provision and clinical decision-making for those at risk of reulceration.

*“... this study may better direct service provision and clinical decision-making for those at risk of reulceration.”*

If confirmed by other studies, the findings of this study may better direct service provision and clinical decision-making for those at risk of reulceration. Any reduction in reulceration will reduce the costs associated with active diabetic foot ulceration. Whether interventions to reduce ulcer recurrence would offset the cost of these preventative measures requires further study, but the benefits to the individual of remaining ulcer-free are clear. ■

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