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# Angiology

## Factors associated with ulcer healing and quality of life in patients with diabetic foot ulcer.

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SCHOLARONE™  
Manuscripts

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3 **1 Factors associated with ulcer healing and quality of life in patients**  
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6 **2 with diabetic foot ulcer.**  
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8 Original Article

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2  
3 **Abstract:**  
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6 A prospective non-randomized cohort study on consecutive diabetic patients with foot  
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8 ulcer was undertaken, to assess factors associated with the healing process or limb  
9  
10 salvage, and evaluated the impact of their treatment on their quality of life (QOL).  
11  
12 QOL was evaluated using diabetic foot ulcer scale-short form questionnaire (DFS-SF)  
13  
14 before and after treatment. A total of 103 diabetic patients with ulcer (mean age  
15  
16 69.7±9.6 years, 77% male) were treated and followed up for 12 months. Ulcer  
17  
18 healing, minor amputation and major amputation rates were 41, 41 and 18%,  
19  
20 respectively while mortality rate was 18%. Ulcer healing was associated with  
21  
22 University of Texas wound grade I and the SIDESTEP trial's diabetic foot infection  
23  
24 wound score. Limb loss was associated with non-palpable popliteal artery, longer in-  
25  
26 hospital stay and delay until referral. QOL was improved in all domains of DFS-SF  
27  
28 (p<0.0001) throughout the cohort of our patients regardless of their outcome and no  
29  
30 outcome (healing, minor or major amputation) was superior to other. Significant  
31  
32 improvement was observed in all domains of hygiene self-management after  
33  
34 consultation during follow up period.  
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43 **Key words:** Diabetic foot; ulcer; quality of life; limb loss.  
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## 1 Introduction

2 The International Diabetes Federation (IDF) reported that the global  
3 prevalence of diabetes (DM) in adults was 8.3% in 2013 expecting to rise beyond 592  
4 million by 2035 with a 10.1% global prevalence.<sup>1</sup> One of the most insidious  
5 complications of DM is foot ulcer and according to the World Health Organization  
6 (WHO), all foot complications may be encompassed under the term DFS (diabetic  
7 foot syndrome) defined as “ulceration of the foot associated with neuropathy and  
8 different grades of ischemia and infection.”<sup>2</sup> DFS was always a multinational burden  
9 and in recognition of this reality the St. Vincent Declaration in 1989 included a set of  
10 goals for the health care of people with DM.<sup>3</sup> In response to the emerging pandemic of  
11 DM type 2, after this declaration, several other regional partnerships between the IDF  
12 and WHO, proceeded with their own declarations such as: the Declaration of the  
13 Americas or DOTA (1996),<sup>4</sup> the Western Pacific Declaration on Diabetes (WPDD  
14 2000)<sup>5</sup> and the Declaration and Diabetes Strategy for Sub-Saharan Africa (2006).<sup>6</sup>

15 Various wound classification systems have been developed, so there will be a  
16 common ‘language’ among the physicians and a helpful tool in the planning and  
17 monitoring of treatment and in predicting the outcome of ulcer healing and assessing  
18 the associated factors.<sup>7,8,9,10,11</sup> Many practical guidelines have been published with  
19 most recent one the evidence-based global consensus for the prevention and  
20 management of diabetic foot by the International Working Group on the Diabetic  
21 Foot (IWGDF) Editorial Board.<sup>12</sup>

22 Along with increased morbidity, foot ulcers can lead to lifelong disability and  
23 may substantially diminish the quality of life (QOL) for these patients.<sup>13</sup> Specifically,  
24 patients with DFS have restrictions on mobility, poor psychosocial adjustment, and  
25 lower self-perceptions of health than patients who do not have ulcers.<sup>13,14</sup> An

1 understanding of the specific effects of DFS on individual patients' QOL is central to  
2 the direction of treatment, adherence to treatment, and patient/practitioner  
3 communication.

4 The aim of this observational study was primarily to assess the factors  
5 associated with the healing process or limb salvage in diabetic patients with foot  
6 ulceration. We also evaluated the impact of treatment and QOL outcomes.

## 8 **Methods**

9 A prospective non-randomized cohort study on consecutive diabetic patients  
10 with foot ulceration was undertaken in a Mediterranean country (Central Greece, an  
11 area with mainly agricultural production) by a tertiary centre which has the only  
12 existing foot clinic service in the region. These were patients with DM type 2  
13 suffering from lower limb ulceration who were referred to our service either at the  
14 outpatient clinic or as an emergency. Exclusion criteria were: i) malnutrition (body  
15 mass index: BMI < 18), ii) immobility (bed or wheel chair bound or stroke limb), iii)  
16 immune-suppression, and, iv) lacking mental capacity to consent to the study.

17 The patients were under close follow up since their first assessment and had  
18 regular appointments in the outpatient clinic of our service depending on their ulcer  
19 healing progress. On the first visit, demographics (age, sex, height, weight, body mass  
20 index-BMI) and personal details (residence address, occupation, carer identity) and  
21 the past medical history, including duration of DM, history of hypertension (HT),  
22 hyperlipidemia (HL), coronary artery disease (CAD), atrial fibrillation (AF),  
23 peripheral artery disease (PAD), chronic kidney disease (CKD), chronic obstructive  
24 pulmonary disease (COPD), cerebrovascular disease (CVD), ophthalmopathy, history

1 of smoking and alcohol, antiplatelet and statin therapy were recorded. Additionally,  
2 family history of HT, HL and DM was also recorded.

3 In addition, all patients received clinical assessment by a Vascular Surgeon,  
4 including palpation of the peripheral arteries, Ankle brachial index (ABI)  
5 measurement, ulcer evaluation and a recording of self-management hygiene (self-  
6 examination, foot washing, foot hydration, the way of cutting their nails, walking  
7 barefoot and usage of special anatomical shoes). Ulcer evaluation was undertaken  
8 according to three grading systems: i) the University of Texas wound classification  
9 which is a system for diabetic foot wounds that evaluates wound depth, the presence  
10 of infection, and peripheral arterial occlusive disease in every category of the wound  
11 assessment,<sup>9</sup> ii) the diabetic foot infection (DFI) wound score based on SIDESTEP  
12 trial (Study of Infections in Diabetic feet comparing Efficacy, Safety and Tolerability  
13 of Ertapenem versus Piperacillin/tazobactam) with the measurement of 10-items,<sup>10</sup>  
14 and, iii) the Society for Vascular Surgery developed a Lower Extremity Threatened  
15 Limb Classification System in which the risk stratification is based on 3 major factors  
16 that impact amputation risk and clinical management such as wound, ischemia and  
17 foot infection (WIFI).<sup>11</sup> The goal of all these systems is to improve communication,  
18 leading to a less complex, more predictable treatment course and, ultimately, an  
19 improved result.

20 Additionally, neuropathic pain (NP) was also assessed using LANSS (Leeds  
21 Assessment of Neuropathic Symptoms and Signs) scale questionnaire.<sup>15</sup> Patient  
22 replies to the questions were a “yes or no” type and were evaluated differently  
23 depending upon the question. For this purpose we used the Greek validated LANSS  
24 questionnaire.<sup>16</sup>

1 Since this is an observational study, each Vascular Surgeon could decide on  
2 the diagnostic investigations needed [foot X-Ray, Duplex scan, Computed  
3 Tomography Angiography (CTA), Digital Subtraction Angiography (DSA)] and on  
4 the type of treatment (open surgery, endovascular, hybrid procedures or conservative).  
5 Primary outcomes were ulcer healing and minor or major amputation. Analysis of the  
6 factors associated with the primary outcomes was undertaken. Secondary outcomes  
7 were the impact in QOL after each type of treatment and self-management at 12-  
8 month follow up.

9 A multidisciplinary approach program was established in our hospital  
10 regarding these patients.

11 Regarding the assessment of patient QOL, we used the Greek version of  
12 Diabetic Foot Ulcer scale- short form (DFS-SF) as translated by Mapi Research Trust-  
13 All (Copyright © 2015 rights reserved).<sup>17</sup> The DFS was developed to measure the  
14 impact of diabetic foot ulcers on QOL issues most important to patients. The DFS was  
15 also translated into several languages using both forward and backward translations  
16 and cognitive debriefing to ensure cultural equivalence. The DFS contains a total of  
17 64 items, 58 of which are used to compute 15 QOL subscales.<sup>18</sup> The 6 remaining  
18 items address employment-related issues and are not included in computation of  
19 subscale scores on the DFS long form.

20 The final version of the DFS-SF (short-form)<sup>17</sup> which is used broadly contains  
21 a total of 29 items grouped into six subscales:

- 22 - Leisure (5 items)
- 23 - Physical health (5 items)
- 24 - Dependence/daily life (5 items)
- 25 - Negative emotions and worried about ulcers/feet (10 items)



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3 - Bothered by ulcer care (4 items)  
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5           Thus, each patient had to fill the DFS-SF questionnaire during the first  
6  
7 examination, and after 12 months of follow up. Also, the QOL was analyzed in  
8  
9 respect to the ulcer treatment, the patient's residence and the level of their home care.  
10  
11 Additionally, Visual Analogue Scales for the impact of pain on daily living activities  
12  
13 of (VAS-ADL) (0–10) and a 10 cm visual analog scale for the pain intensity (VAS-  
14  
15 INT) (0, no pain; 10, unbearable pain)<sup>15</sup> were recorded at their first visit to the  
16  
17 outpatient clinic and their last one.  
18  
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20  
21           This study involved the collection of existing data and diagnostic tests that  
22  
23 have been recorded in such a manner that subjects could not be identified, either  
24  
25 directly or through identifiers linked to the subject. However, the protocol and  
26  
27 informed consent were approved by the Institutional Review Board.  
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#### 32 **Statistical analysis**

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34           The relationships of categorical variables and the main outcomes observed  
35  
36 (ulcer healing, minor amputation, major amputation, mortality) was examined with  
37  
38 the use of the Chi Square statistic, while the relationships between main outcomes and  
39  
40 continuous measurements was assessed with the independent samples t-test or the  
41  
42 Mann Whitney test, where appropriate. The findings were assessed and the  
43  
44 statistically significant variables were entered in a binary logistic regression model.  
45  
46 The two way interaction effects were also considered to reach the final model for each  
47  
48 outcome. For the change in the Quality of life Measures the Paired samples t-test was  
49  
50 applied for each of the dimensions measured. Statistical significance was set at 0.05  
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52 (two-sided). The analysis was carried out with the use of SPSS v.21.0  
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## 1 Results

2 Over a period of 2 years (2012-2014) 103 consecutive patients with diabetic  
3 foot ulcer entered into the study and were followed up for 12 months. Only 2 patients  
4 were already excluded due to the exclusion criteria. The mean age of the patients was  
5  $69.7 \pm 9.6$  years and most of them were males (76.7%, 79/103). More than half of the  
6 patients were manual workers and almost everyone was cared for by family members.  
7 The population was overweight with mean BMI of 28. Most of the patients were on  
8 antiplatelet (80%) and statin (70%) therapy, while half of them were also on insulin.  
9 Social-demographics, past-medical history details and blood test results are presented  
10 in table 1.

11 Almost half of the patients (47%, 49/103) presented directly to our hospital as  
12 an emergency, while 20% (21/103) were referred by an endocrinologist, 11.5%  
13 (11/103) by a general surgeon, 11.5% by a general practitioner (GP), 3.8% (4/103) by  
14 another vascular surgeon, 3% (3/103) by an internal medicine physician, 2% (2/103)  
15 by a nephrologist, 1% (1/103) by a neurologist and 1% (1/103) by an orthopedic  
16 department. The mean time until referral to our service was  $23.8 \pm 9$  days. There was  
17 no difference between patients with self-referral and physician referral. However,  
18 there was a seasonal variation in the presentation and referral of these patients to our  
19 service peaking in colder months during the year (autumn and winter, 64%, 66/103 vs  
20 spring and summer 36%, 37/103,  $p < 0.05$ ). The most common cause of ulcer was  
21 trauma (lack of attention 68%, 70/103; shoe wearing trauma 11.7% ,12/103); after  
22 great saphenous harvesting 2% (2/103); after nail cutting 1% (1/103); and 17.5%  
23 (18/103) by unknown cause. The ulcers were confined mainly to toes (64%, 66/103),  
24 and less frequently to the shin (9.7%, 10/103), the sole (7.8%, 8/103), the heel (7.8%,

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3 8/103), the dorsal surface of the foot (5.8%, 6/103), the ankle (2.9%, 3/103) and in a  
4  
5 previous amputation stump area (1.9%, 2/103) (Figure 1).  
6

7 In table 2 patients are categorized according to the University of Texas wound  
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9 classification system (i) and according to the Lower Extremity Threatened Limb  
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11 Classification System (WIFI) (ii). Additionally, the mean DIF wound score was  
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13 20.4±3, while the mean LANSS score was 20.5±3.4 (all patients in our study had  
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15 LANSS score > 12).  
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17

18 During 12 month of follow up, 41% (42/103) of the patients had their ulcer  
19  
20 healed. From this group, 40.5% (17/42) of the patients were healed in the first month,  
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22 85.7% (36/42) in first 3 months and 97.6% (41/42) in first 6 months. A further 50.5%  
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24 (52/103) of the patients underwent a minor amputation, 63% (33/52) of which during  
25  
26 first hospitalization, 88.5% (46/52) during first 3 months and 98% (51/52) during first  
27  
28 6 months after initial presentation. All but 9 patients achieved healing of their minor  
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30 foot amputation. These 9 patients along with another 9 underwent major amputation  
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32 accounting for a 17.6% (18/103) limb loss. Most of the amputations (14/18, 77%)  
33  
34 were undertaken in first 6 months.  
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38 After multiple logistic regression analysis including characteristics of tables,  
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40 referral characteristics and ulcer location and causes, ulcer healing was associated  
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42 with University of Texas wound classification and DIF wound score. Patients with  
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44 TEXAS grade I ulcer had 23-fold more often ulcer healed (95% CI 2.3-220, p=0.007)  
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46 than those with a higher grade. Additionally, after increase of one DIF score unit, the  
47  
48 odds risk for ulcer non-healing is increased by 15% (95% CI 1.5-30%, p=0.028), with  
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50 mean DIF score 17±2 for ulcer healed patients and 24.5±3 for non-healed patients.  
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54 (Figure 2)  
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3 1 Minor amputation was associated with Texas classification, COPD and  
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5 2 LANSS score. Patients with TEXAS grade II or higher had 11.3 increased odds risk  
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7 3 for minor amputation (95% CI 3.4-38,  $p<0.001$ ) than those with grade I. Additionally,  
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9 4 patients with COPD had 12.3 increased odds risk for minor amputation (95% CI 2.1-  
10  
11 5 73  $p=0.006$ ), while for every increase of one unit of LANSS score the odds risk for  
12  
13 6 minor amputation is increased by 43% (95% CI 2-100%,  $p=0.040$ ). (Figure 3)

16 7 Major amputation was associated with palpable pulses of popliteal artery,  
17  
18 8 hospital stay and time until referral. Every patient with non-palpable popliteal artery  
19  
20 9 had 5.2 increased odds risk for major amputation (95% CI 1.03-26  $p=0.045$ ). For each  
21  
22 10 additional hospital stay the odds risk for a major amputation increased by 8% (95% CI  
23  
24 11 2-14%  $p=0.007$ ). Finally, for each additional day of delay until referral the odds risk  
25  
26 12 for major amputation increased by 3.5% (95% CI 1-6%  $p=0.011$ ).

29 13 Among patients with evidence of ischemia requiring revascularization, no  
30  
31 14 differences were observed in respect to healing rate, minor and major amputation  
32  
33 15 according to the type of intervention; 36 patients underwent 38 procedures: 20  
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35 16 endovascular only, 9 open only and 9 hybrid ones and the total healing rate was  
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37 17 30.5% (11/36). In patients who were not considered candidates for revascularization  
38  
39 18 (67/103), a reasonable healing rate was observed (46%, 31/67).

42 19 Lack of multidisciplinary assessment was observed in a large number of  
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44 20 patients and therefore during their initial hospitalization they were referred for  
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46 21 evaluation to other services: 65 (63%) patients to Endocrinology for DM control, 34  
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48 22 (33%) to Cardiology, 8 (7.7%) to Nephrology, 8 (7.7%) to Ophthalmology, 6 (5.8) to  
49  
50 23 Orthopedics, 4 (3.8) to a Chest Medicine and 1 (1%) to Neurology.

53 24 The mortality rate was 17.5% (18/103) during the 12 month period.  
54  
55 25 Myocardial infraction (MI) accounted for the majority of deaths (72%, 13/18), while 3  
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1 patients died because of severe sepsis and 1 due to acute renal failure. After  
2 multivariate analysis only age was associated with death. For each one additional year  
3 of age, the risk of death was increased by 17% (95% CI 7 -29% p=0.001). During 12-  
4 month follow up no patient had a development of a new ulcer or a deterioration of a  
5 healed one.

6 All alive in 12 month-follow up patients completed the QOL questionnaire  
7 (DFS-SF) in their first and the last assessment (12-month follow up); 82.5% (85/103)  
8 were available for QOL assessment at 12-month follow up. QOL was significantly  
9 improved in all domains of DFS-SF (p<0.0001) throughout the cohort of our patients  
10 after their treatment as compared with their condition before treatment. (Table 4) In  
11 addition, after further analysis, it appeared that the improvement of QOL was not  
12 associated with the type of treatment and the outcome, thus there was no difference in  
13 improvement of QOL among patients regardless of whether they had their ulcer  
14 healed or had undergone an amputation. The lower improvement in QOL was  
15 demonstrated in domains related to physical health (mean increase 9.9), dependency  
16 in daily life (mean increase 10.9), treatment satisfaction (mean increase 12.4) and  
17 higher improvement in domains related to leisure (mean increase 16.5) and negative  
18 emotions (mean increase 18.2). Finally, when QOL was analyzed according to the  
19 patient residency area and the caring person, no correlation was identified. A  
20 significant improvement was observed in all domains of hygiene self-management  
21 between the first and the last assessment (12 months) of follow up while VAS of both  
22 types were improved significantly during follow up.(Table 3)

## 24 Discussion

1 In our study, the mean duration of DM among patients was  $18 \pm 3$  years.  
2  
3 However, it was demonstrated that their actual awareness about the nature of the  
4 disease was inadequate. Thus, 50% of our patients presented to our service late from  
5 the onset of the ulcer (mean time 24 days), with a poorly controlled DM (mean  
6 Hb1AC: 8.1% and BMI: 28) and low awareness of hygiene self-management (table  
7 3). It has been previously demonstrated that foot self-care is generally infrequent, and  
8 clinical monitoring in outpatient clinics is performed for less than half of diabetic  
9 patients with foot ulcers.<sup>19</sup> In practice, patient education aiming to promote foot care  
10 knowledge and self-examination is advocated by most experts and guidelines as an  
11 important strategy to prevent diabetic foot complications. Education of patients at  
12 high risk of or with ulceration is considered to be particularly important.<sup>20</sup> In some  
13 trials, foot care knowledge and self reported patient behavior seem to be positively  
14 influenced by education in the short term.<sup>21</sup> In our study after many consultations of  
15 our patients during follow up, they managed to improve their hygiene self-  
16 management status considerably (Table 3), decreasing the likelihood of a new ulcer.  
17 However, the effect of patient education is still in doubt and there is insufficient  
18 robust evidence that limited patient education alone is effective in achieving clinically  
19 relevant reductions in ulcer and amputation incidence.<sup>21</sup> Additionally, in our study,  
20 almost half of the patients had a late referral by their physician, and thus it would  
21 seem advisable to implement strategies oriented towards the improvement of primary  
22 care physician awareness of diabetic foot and its complications, along the IWGDF  
23 recommendations that healthcare professionals should receive periodic education to  
24 improve the care of high-risk individuals.<sup>12</sup> It is true that such patients may neglect  
25 themselves because of various reasons including impaired sensation due to  
neuropathy, impaired vision as a result of retinopathy, and other co-morbidities

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2  
3 including cardiac and renal impairment which all may contribute also to the lack of a  
4  
5 personal alarm system.<sup>22,23</sup>  
6

7  
8 It is still debatable whether ulcer healing in diabetic patient always requires  
9  
10 revascularization. Although, in a recent systematic review, it was demonstrated that  
11  
12 improved rates of limb salvage were associated with revascularization compared with  
13  
14 the outcomes of conservatively only treated patients, there were insufficient data to  
15  
16 recommend one method of revascularization over another.<sup>24</sup> Along this line, in our  
17  
18 study, no differences were observed in respect to healing rate, minor and major  
19  
20 amputation according to the type of intervention. However, this was an observational  
21  
22 study and not designed to compare those treatments. Over the last decade, there has  
23  
24 been a marked shift from open revascularization to an endovascular one in diabetic  
25  
26 patients with foot ulcer<sup>25</sup> and in some centers endovascular treatment is used first as  
27  
28 "preliminary approach" for critical limb ischemia and diabetic foot.<sup>26</sup> Additionally, in  
29  
30 patients who were not considered candidates for revascularization, a reasonable  
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32 healing rate was observed (46%, 31/67). Recently, it was suggested that even diabetic  
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34 patients with ischemic foot ulcers not available for revascularization, should not be  
35  
36 excluded from healing without major amputation.<sup>27</sup>  
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39  
40 The SIDESTEP trial has demonstrated that the clinical response was less  
41  
42 favorable at the follow-up assessment in patients with a DIF score >19.<sup>10</sup> Along this  
43  
44 line, our study showed that patients with healed ulcer had a score of mean value 16.8  
45  
46 (figure 2). Another important factor that was associated with ulcer healing was the  
47  
48 TEXAS classification during first examination. Thus, it seems that initial clinical  
49  
50 evaluation with the use of DIF score and TEXAS classification may help physicians  
51  
52 to identify which patients are at increased risk for non-healing ulcers or even limb  
53  
54 loss, and in whom closer follow up and more aggressive treatment may be indicated.  
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3 1 As far as the predictive factors associated with limb loss are concerned, it has  
4  
5 2 been previously demonstrated that male gender and the presence of neuropathy,<sup>28</sup>  
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7 3 Severity of Diabetic Foot Infection,<sup>29</sup> elevated fasting blood sugar,<sup>30</sup> WBC and  
8  
9 4 PAD,<sup>31</sup> are associated with amputations. In our study, Texas classification, COPD and  
10  
11 5 LANSS score were associated with minor and delay of hospital referral, the severity  
12  
13 6 of PAD, and the prolonged hospitalization were associated with major amputation. It  
14  
15 7 seems that detailed initial clinical assessment and fast-track management of DFS are  
16  
17 8 important factors associated with limb loss. Furthermore, it is of note that the majority  
18  
19 9 of deaths in our cohort were cardiac related. This underlines the importance of  
20  
21 10 cardiovascular disease risk factor control as primary prevention in patients with DM 2  
22  
23 11 as it has been recommended from the American Heart Association and the American  
24  
25 12 Diabetes Association.<sup>32</sup>

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28  
29 13 The evaluation of the patient QOL has been recognized as an important area of  
30  
31 14 scientific knowledge, since the concept of QOL has been related to the notion of  
32  
33 15 health: satisfaction and well-being in the physical, psychological, socio-economic and  
34  
35 16 cultural spheres.<sup>33</sup> According to the WHO, QOL can be defined as an individuals'  
36  
37 17 perception of their position in life in the context of the culture and value systems in  
38  
39 18 which they live in and in relation to their goals, expectations, standards and  
40  
41 19 concerns.<sup>34</sup> Studies have evaluated and reported on QOL in diabetic patients with  
42  
43 20 ulcer and compared them with other control groups.<sup>13,34-38</sup> Presence or history of  
44  
45 21 diabetic foot ulceration has been proved to have a large impact on physical  
46  
47 22 functioning and mobility.<sup>38</sup> Diabetic foot ulcer patients had much worse health related  
48  
49 23 QOL (HRQL) compared with the diabetes population and the general population,  
50  
51 24 especially in physical health.<sup>13,36-38</sup> Our study is the first to our knowledge that  
52  
53 25 evaluates the QOL in the same group of patients before and after treatment. Thus, in  
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3 1 our study the presence of diabetic foot ulcer was associated with poor QOL, and QOL  
4  
5 2 was significantly improved in all domains of throughout the cohort of our patients  
6  
7 3 after the ulcer management. However, it was interesting, that QOL was improved  
8  
9 4 regardless of patient outcome (healing, minor or major amputation) and no outcome  
10  
11 5 was superior to another. Similarly, VASs were improved after treatment in our cohort.  
12  
13 6 Even in cases that a major amputation was undertaken, the patients perceived their  
14  
15 7 situation as improved in terms of QOL. A recent report was in agreement with that  
16  
17 8 outcome, suggesting that clinicians should not assume that patients will experience  
18  
19 9 poorer QOL outcome only because they underwent an amputation.<sup>34</sup> An  
20  
21 10 understanding of the specific effects of chronic diabetic foot ulcers on individual  
22  
23 11 patient QOL is central to the direction of treatment, management of compliance, and  
24  
25 12 patient/practitioner communication.  
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29  
30 13 Patients with a diabetic foot ulcer should to be assessed holistically, thus  
31  
32 14 intrinsic and extrinsic factors should be addressed and managed by a multidisciplinary  
33  
34 15 diabetic foot team (MDFT) of physicians as soon as possible (within one working day  
35  
36 16 of presentation or even immediately in the presence of severe infection).<sup>12,39,40</sup>  
37  
38 17 However, in many hospitals not only in our country, but also in the Mediterranean  
39  
40 18 region,<sup>41</sup> a MDFT approach has not been adopted and physicians have to work as  
41  
42 19 individuals on diagnosis and management and attempt to refer patients to other  
43  
44 20 specialties when they consider that it is necessary. Studies, have demonstrated that the  
45  
46 21 introduction of a MDFT has been associated with a reduction in the incidence of  
47  
48 22 major amputations in patients with DM.<sup>42,43</sup>  
49  
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51  
52 23 Potential selection and treatment biases may exist as about 50% of patients  
53  
54 24 had PAD, because this study was a prospective observational one, in patients referred  
55  
56 25 to the Vascular Service of a tertiary Hospital. However, this reflects the real world  
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3 1 practice of a Vascular Service which inevitably is committed to deal with more  
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5 2 difficult-to-heal ulcers.  
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## 11 5 **Conclusions**

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14 6 Our observational study showed that delayed hospital referral, prolonged  
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16  
17 7 hospitalization and absence of popliteal pulses were associated with limb loss.  
18  
19 8 Additionally, initial clinical status assessment with DIF score and TEXAS  
20  
21 9 classification may predict ulcer healing. QOL improved in all patients after treatment  
22  
23 10 regardless of the outcome (healing or amputation). Also, improvement was observed  
24  
25 11 in the hygiene self-management.  
26  
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29 12

## 30 13 **No conflict of interest.**

### 31 14 Author contribution

32  
33  
34 15 All authors contributed to: (1) substantial contributions to conception and design, or  
35  
36  
37 16 acquisition of data, or analysis and interpretation of data, (2) drafting the article or  
38  
39 17 revising it critically for important intellectual content, and, (3) final approval of the  
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42 18 version to be published.  
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Socio-Demographics		Past medical history		Blood test	
Sex	76.7% Males (79/103)	Type of Diabetes	100% Type 2		Mean±SD
Age in years	69.7±9.63	Mean duration of DM in years	17.7±7.9	Hb	11.9±1.7g/dL
Mean height in cm	164.7±24.4	HT	93.2% (96/103)	WBC	13±3 10 <sup>3</sup> /μL
Mean weight in kg	79.23±16.7	CAD	55.3% (57/103)	Neu	72.8±9.5%
Mean BMI in kg/m <sup>2</sup>	28±5.1	AF	12.6% (13/103)	PLT	277±111 10 <sup>3</sup> /μL
Residency		PAD	53.4% (55/103)	MPV	8.6±1.2 fL
Urban	53.4% (55/103)	Mean ABI R	0.9±0.3	ESR	36.8±20.3mm/h
Countryside	46.6% (48/103)	Mean ABI L	0.7±0.2	CRP	4.9±2.4mg/dL
Occupation		Patients with non-compressible ABI	29% (30/103)	Cr	1.0±0.3mg/dL
White collar worker	25.2% (26/103)	DSA	38.8% (40/103)	Ur	45±26mg/dL
Manual worker	54.4% (56/103)	CTA	2% (2/103)	Na	137.2±14mmol/L
Unemployed	20.4% (21/103)	CRD	20.4% (21/103)	K	4.6±1.2mmol/L
Home carer		HL	74.8% (77/103)	ALT	24±24 IU/L
Spouse	46.6% (48/103)	COPD	11.7% (12/103)	AST	28±25 IU/L
Descendants	47.6% (49/103)	CVD	12.6% (13/103)	CK	106±97U/L
Alone	5.8% (6/103)	History of alcohol consumption	23.3% (24/103)	LDH	202±92IU/L
Family history of DM	44.6% (46/103)	History of smoking		Bilirubin	0.5±0.3mg/dL
Family history of PAD	15.5% (16/103)	No	27.2% (28/103)	Total Chol	167±52mg/dL
Family history of CAD	76.7% (79/103)	Yes	25.2% (26/103)	Trig	168±73mg/dL
		Ex smoker	47.6% (49/103)	LDL	111±49mg/dL
		History of ophthalmopathy		HDL	42±14mg/dL
		None	25.2% (26/103)	INR	1±0.3
		Mild	42.7% (44/103)	APTT	32.3±6sec
		Moderate	22.3% (23/103)	PT	18.2±5sec
		Severe	9.7% (10/103)	HbA1C	8.1±1.2%
				Negative ulcer cultures	63% (65/103)

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5 Table 1. Social-demographics, past-medical history details and blood test results of  
6  
7 each patient.  
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10 BMI: body mass index; DM: diabetes mellitus; PAD: peripheral artery disease; CAD:  
11  
12 coronary artery disease; HT: hypertension; AF: atrial fibrillation; ABI: ankle brachial  
13  
14 index; DSA: digital subtraction angiography; CTA: computed tomography  
15  
16 angiography; CRD: chronic renal disease; HL: hyperlipidemia; COPD: chronic  
17  
18 obstructive pulmonary disease; CVD: cerebrovascular disease; Hb: hemoglobin;  
19  
20 WBC: white blood cells; Neu: neutrophils; PLT: platelets; MPV: mean platelet  
21  
22 volume; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; Cr:  
23  
24 creatinine; Ur: Urea; Na: sodium; K: potassium; ALT: alanine transaminase; AST:  
25  
26 aspartate transaminase; CK: creatine kinase; LDH: lactate dehydrogenase; Chol:  
27  
28 cholesterol; Trig: triglycerides; LDL: low-density lipoprotein; HDL: high-density  
29  
30 lipoprotein; INR: international normalized ratio; APTT: activated partial  
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32 thromboplastin time; PT: prothrombin time; HbA1C: hemoglobin A1C; cm:  
33  
34 centimeter; kg: kilogram; m: meter; µl: microlitre; fl: femtolitre; mm: millimeter; h:  
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36 hour; IU: International Units; L: Litre; mmol: millimole; U: units; dL: deciliter; sec:  
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i.

Stage	Grade			
	0	I	II	III
A	0	3	0	0
B	0	28	16	3
C	0	30	10	
D	0	8	4	1

ii.

	Ischemia 0				Ischemia 1				Ischemia 2				Ischemia 3			
W0																
W1	1	14			6	1			2	15	4		2	12		
W2		2	5	2		3				1	2			1	1	
W3				1							1					
	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3

Table 2. i. Patients categorized according to Texas Wound Classification system.<sup>6</sup>

ii. Patients categorized according to Wound Ischemia Foot infection Classification system,<sup>8</sup> (W: wound; F: foot infection).

Self-management				
First examination		After 12 month of follow up		
<b>Mean Self-examination per week</b>	1.84	<b>Mean Self-examination per week</b>	8.4	p< 0.05
<b>Mean Foot washing per week</b>	3.9	<b>Mean Foot washing per week</b>	7.8	p< 0.05
<b>Mean foot hydration per week</b>	0.66	<b>Mean foot hydration per week</b>	7	p< 0.05
<b>Cutting nails</b>		<b>Cutting nails</b>		
Him/herself	64% (66/103)	Him/herself	11.6% (12/103)	p< 0.05
Other	34% (35/103)	Other	70.9% (73/103)	p< 0.05
Specialist	2% (2/103)	Specialist	17.4% (18/103)	p< 0.05
<b>Sock selection</b>	11.6% (12/103)	<b>Sock selection</b>	79.6% (82/103)	p< 0.05
<b>Special anatomical shoes</b>		<b>Special anatomical shoes</b>		
No	92.2% (95/103)	No	80% (83/103)	ns
<b>Walking barefoot:</b>		<b>Walking barefoot:</b>		
Yes	42.7% (44/103)	Yes	7.6% (8/103)	p< 0.05
Visual analog scales				
<b>Mean VAS ADL</b>	6.8±2.5	<b>Mean VAS ADL</b>	4.2±1.2	p< 0.05
<b>Mean VAS INT</b>	6.3±2.2	<b>Mean VAS INT</b>	2.8±1.3	p< 0.05

Table 3. Hygiene self-management assessment between the first and the last examination (12 months) of follow up. A 10 cm visual analogue scale for the impact of pain on daily living activities of (VAS-ADL) (0–10) and a 10 cm visual analog scale for the pain intensity (VAS-INT) (0, no pain; 10, unbearable pain. ns: not significant.

		Mean	Std. Deviation	Std. Error Mean	P values
Pair 1	Leisure after 12-month follow up	45,8796	21,04544	2,02510	,000
	Leisure at 1st examination	29,0741	16,74643	1,61143	
Pair 2	Physical health after 12-month follow up	45,3704	19,55944	1,88211	,000
	Physical health at 1st examination	35,3704	17,23536	1,65847	
Pair 3	Daily activities after 12-month follow up	46,4815	21,16092	2,03621	,000
	Daily activities at 1st examination	35,3704	19,39149	1,86595	
Pair 4	Emotions after 12-month follow up	40,4861	21,45539	2,06455	,000
	Emotions at 1st examination	22,7083	16,58004	1,59542	
Pair 5	Treatment after 12-month follow up	45,1968	22,32484	2,14821	,000
	Treatment at 1st examination	33,1019	18,05081	1,73694	

Table 4. Quality of life assessment in all domains at baseline (1<sup>st</sup> examination) and at 12-month follow up.

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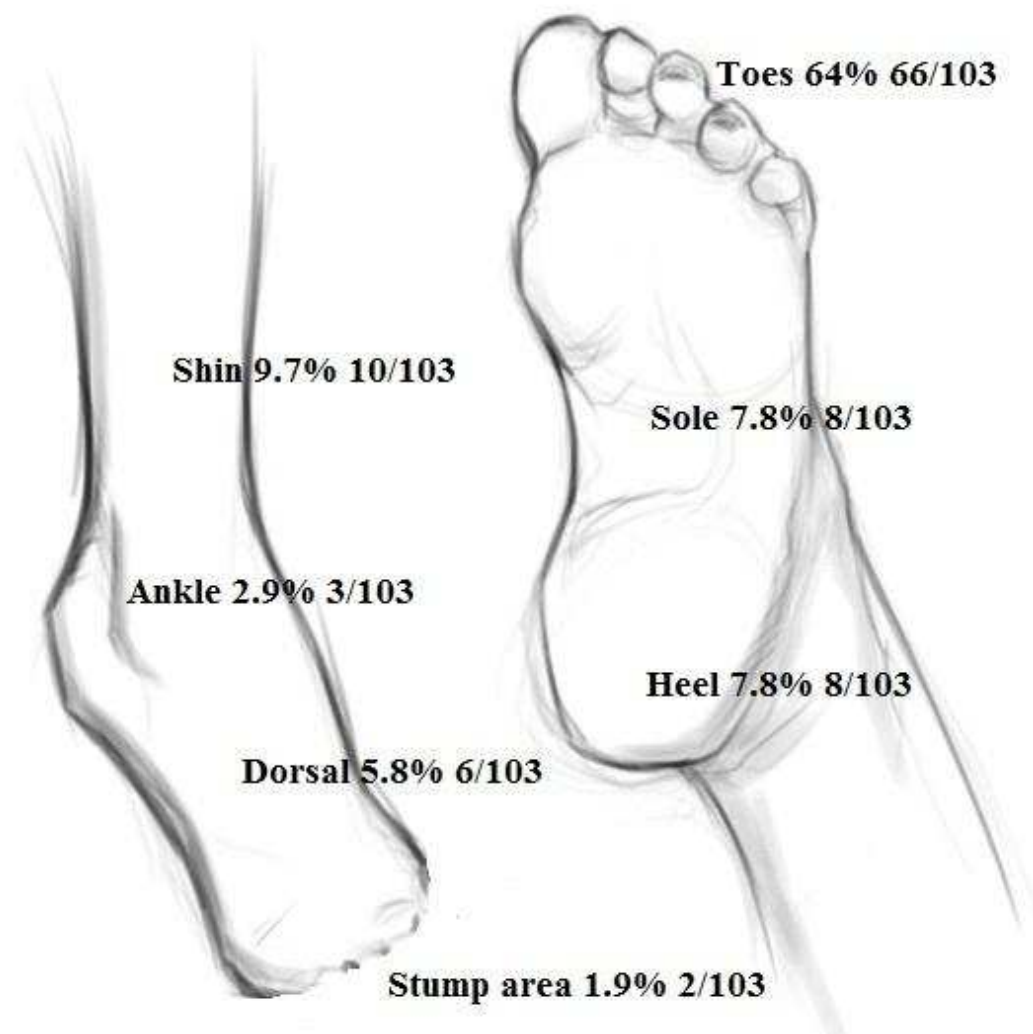


Figure 1. Schematic location of the ulcers.

review

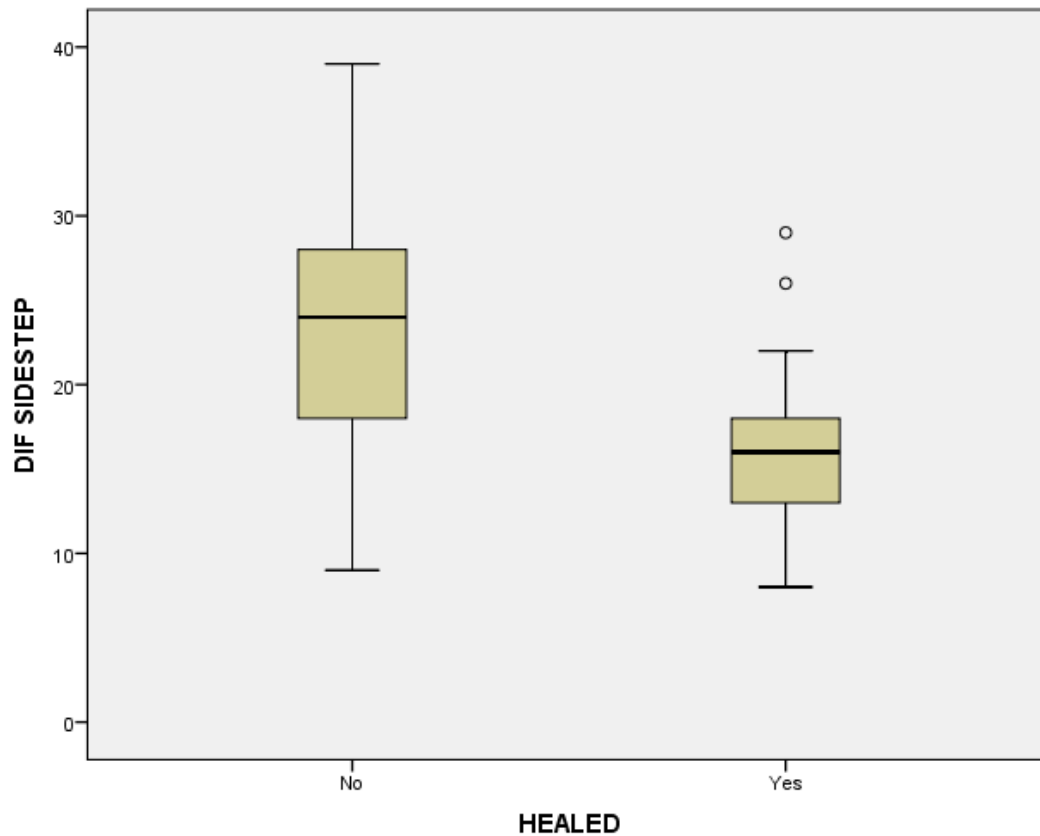


Figure 2. After increase of one DIF score unit, the risk for ulcer non-healing is increased by 15% (95% CI 1.5% – 30%,  $p=0.028$ ), with mean DIF score  $17\pm 2$  for ulcer healed patients and  $24.5\pm 3$  for non-healed patients. (DIF: diabetic foot infection; CI: confidence interval).

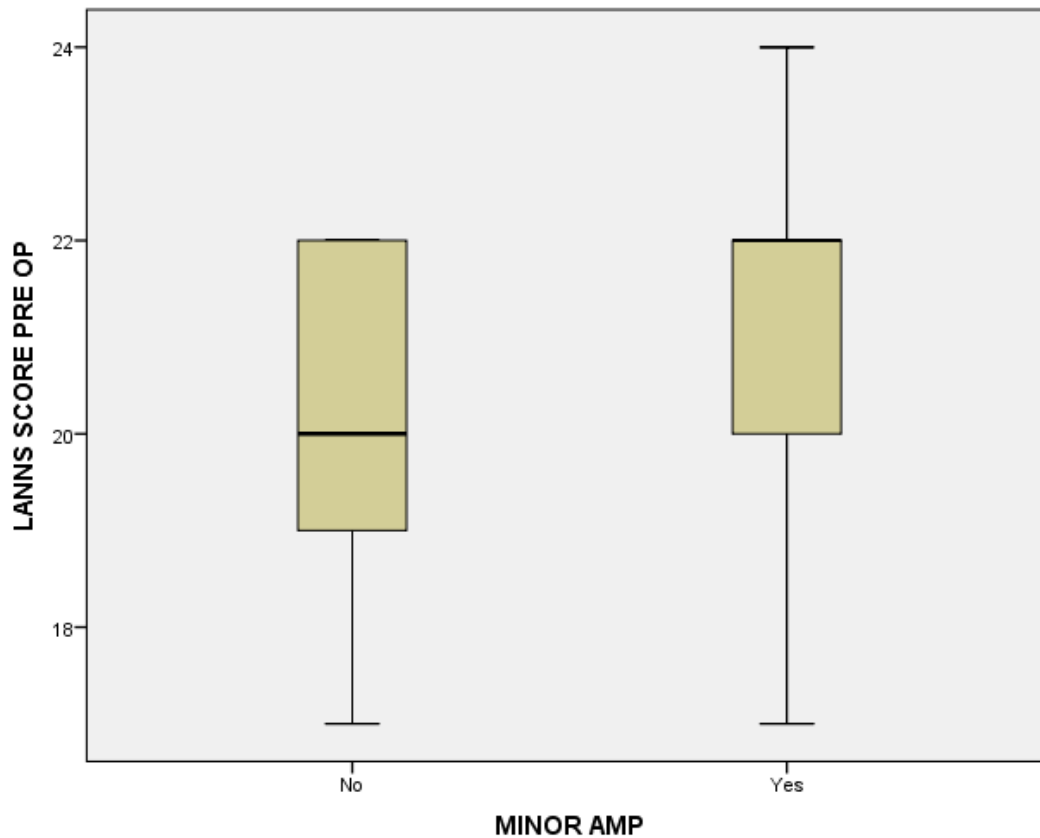


Figure 3. For every increase of one unit of LANSS score the risk for minor amputation is increased by 43% (95% CI 2% – 100%,  $p=0,040$ ). (LANSS: Leeds Assessment of Neuropathic Symptoms and Signs, CI: confidence interval)