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ORIGINAL RESEARCH

A study to correlate duss score with clinical outcome in patients of diabetic foot ulcers

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Abstract

Introduction: Diabetic foot ulcer has been defined as "an ulceration of the foot associated with neuropathy and different grade of ischemia andinfection."[2] The condition is usually secondary to diabetic neuropathy due to uncontrolled diabetes orpoorglycemic status. The site of ulcers in diabetes are typically seen at the area of foot which encounters constant pressure or repetitive trauma. We carried out this study to determine the utility of this scoring system in predicting the clinical outcome of diabetic foot ulcer in routine clinical setting.

Materials and Methodology: This study was adopted as a clinical, prospective, observational, cohort study which was carried out in Out-Patient Department as well as Emergency Department at People's college of Medical Sciences and Research Centre, Bhopal. The duration of the study has been set up around 22 months from December 2020 to September 2022. All the study participants were carefully selected based on the inclusion criteria and Written consent was obtained from all the study participants after explaining them nature and purpose of study.

Results: The association between DUSS score and primary healing showed that the primary healing was significantly better in patients with low DUSS score (0,1) as compared to patients with DUSS score of 2 or above ($p<0.05$). Table – 5 correlated the association between DUSS score and plastic surgery. Therefore the results showed that plastic surgery was done in significantly higher proportions of cases with DUSS score 2 (36.4%), followed by 29% cases with DUSS score 3 ($p<0.05$). When DUSS score and minor amputation were correlated, it has been tabulated that the rate of minor amputation is relatively be higher in patients with DUSS score 3 and 4. The rate of toe amputation was higher in patients with DUSS score 3 whereas the rate of fore foot amputation was higher inpatients with DUSS score 4($p<0.05$).

Conclusion: Advancing age, duration of diabetes and untreated/improper treatment of diabetes mellitus are predictors of high DUSS score that is linked with poor clinical outcome in terms of need of debridement, plastic surgery and amputation. Hence, DUSS score can be a part of day-to-day practice in diabetic clinics to classify the ulcers early and plan the management of patients according to the predicted clinical outcome.

Keywords: diabetes mellitus, diabetic ulcer, amputation, DUSS

Introduction

Diabetic foot ulcer is one of the most common complication of diabetes, for which patients

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seek care in surgery OPD.[1] Diabetic foot ulcer has been defined as "an ulceration of the foot associated with neuropathy and different grade of ischemia and infection."[2] The condition is usually secondary to diabetic neuropathy due to uncontrolled diabetes orpoorglycemic status. The site of ulcers in diabetes are typically seen at the area of foot which encounters constant pressure or repetitive trauma.[1] The diabetic foot ulcers often present as diabetic foot syndrome which is characterized by neurological abnormalities and peripheral vascular in sufficiency along with foot ulceration, infection or destruction of the deep tissues.[3]

Diabetic ulcers results from multiple factors such as long duration of diabetes, poor glycemic control, improper foot care, foot deformity, dry skin, calluses etc. but two major cause of diabetic foot ulcers are underlying diabetic neuropathy and ischemia (due to peripheral vascular disease).[4]

Recently, clinical severity scoring system had been in use for classifying the wounds into various subgroups based upon the severity so that the outcome of wound healing can be predicted. Previously, only one scoring system i.e. the wound severity score system devised by Knighton et al. was used, but its score ranged from 0 to 97. The scoring system was time consuming and has not been widely used. Also the validity of the tool is unknown.[5] Thus, there is a need for a valid and easy to use severity scoring system to classify the ulcers based upon clinical examination, which may help in stratifying the patients according to the prognosis and expected outcome following the treatment. DUSS[6] (diabetic ulcer severity score) is recently introduced score for assessing the severity of ulcer or wound. This scoring system is easy to use, helps in predicting outcome with respect to response to treatment (healing) and complications (amputation). This scale was introduced in 2006 and included four clinical parameters such as location of ulcer, number of ulcers, palpable pedal pulses and probing to bone. The score ranged from 0 to 4 depending upon these four variables.[6] Since its introduction, this scale has been used in various clinical settings to predict the outcome of diabetic foot ulcer in terms of healing and risk of amputation. We carried out this study to determine the utility of this scoring system in predicting the clinical outcome of diabetic foot ulcer in routine clinical setting.

Materials and methodology

This study was adopted as a clinical, prospective, observational, cohort study which was carried out in Out-Patient Department as well as Emergency Department at People's college of Medical Sciences and Research Centre, Bhopal. The duration of the study has been set up around 22 months from December 2020 to September 2022. All the study participants were carefully selected based on the inclusion criteria and Written consent was obtained from all the study participants after explaining them nature and purpose of study.

After obtaining ethical clearance from Institute's ethical committee, all the patients fulfilling the inclusion criteria were enrolled. Detailed history regarding sociodemographic data such as name, age, sex, religion, residence, socioeconomic status etc. was obtained using a proforma. Clinical and personal history was obtained in detail. Detail regarding diabetes and ulcer, its onset, duration, family history of diabetes, glycemic status, medications etc. was obtained. All the patients were then subjected to thorough general, systemic and local examination. Blood glucose levels were estimated in all the cases. Ulcer was evaluated in terms of size of ulcer, site of ulcer, number of ulcers, etc. DUSS was used in our study to predict the outcome. Four variables were obtained for the same and scored as 0 or 1. The DUSS score was calculated by adding these separate scores to a theoretical maximum of 04. Patients were followed-up for 03 months or until complete healing or amputation, if earlier. Outcome was measured in terms of healing-Incomplete or complete, Requirement of plastic surgery– partial skin grafting or flap cover and Amputation–minor or major. Data was compiled using Ms Excel and analysis was done with the help of IBM SPSS software version 20. Continuous

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data was represented as mean and standard deviation whereas categorical data was represented as frequency and proportion. DUSS score was associated with the observed clinical outcome using chi square test.

Results

In table – 1, it has represented that the Mean age of patients with diabetic ulcer was 49.74±9.78 years (Range- 35-82 years) and majority of cases belonged to age range of 45 years or less (39.5%). Only 7.5% cases belonged to more than 65 years of age.

Figure – 1 majorly represented the distribution of cases based on the gender preferences. We reported male predominance ulcer with male: female ratio of 1.15:1. About 53.5% cases were males and only 46.5% cases were females. Figure – 2 denoted the Mean duration of diabetes was 7.98±5.5years(Range-1 to 32years) and duration of diabetes was less than 5years and 5to 10years in 41%cases each.

Table – 2 represented the case distribution based on random blood glucose. Mean RBS among study participants was 267.9±58.0mg/dl(Range-176-396mg/dl) and majority of cases had RBS above 200 mg/dl (84%). Table – 3 tabulated the median DUSS score among the study population was 1 (IQR-0-2) and mean DUSS score was 1.47±1.26 (Range 0-4). Majority of cases had DUSS score of 0 (28.5%), followed by DUSS score1 and 2 in 26.5% and 22% cases respectively. DUSS score of 3 was noted in 15.5% cases whereas 7.5% cases had DUSS score of 4.

The association between DUSS score and primary healing has been tabulated in table – 4 which represented that the primary healing was significantly better in patients with low DUSS score(0,1) as compared to patients with DUSS score of2 or above($p<0.05$). Table – 5 correlated the association between DUSS score and plastic surgery. Therefore the results showed that plastic surgery was done in significantly higher proportions of cases with DUSS score 2 (36.4%), followed by 29% cases with DUSS score3 ($p<0.05$).

When DUSS score and minor amputation were correlated, it has been tabulated that the rate of minor amputation is relatively be higher in patients with DUSS score 3 and 4. The rate of toe amputation was higher inpatients with DUSS score 3 whereas the rate of fore foot amputation was higher inpatients with DUSS score4 ($p<0.05$) [Table - 6]. In table – 7, The rate of major amputation i.e. above knee as well as below knee amputation was significantly higher in patients with DUSS score 4 as compared to those with DUSS score of less than 4 ($p<0.05$).

Table1-Distributionofcases according to age

Age(years)	Frequency(n=200)	Percentage
≤45	79	39.5
46-55	73	36.5
56-65	33	16.5
>65	15	7.5

Figure – 1: Distribution of cases based on age

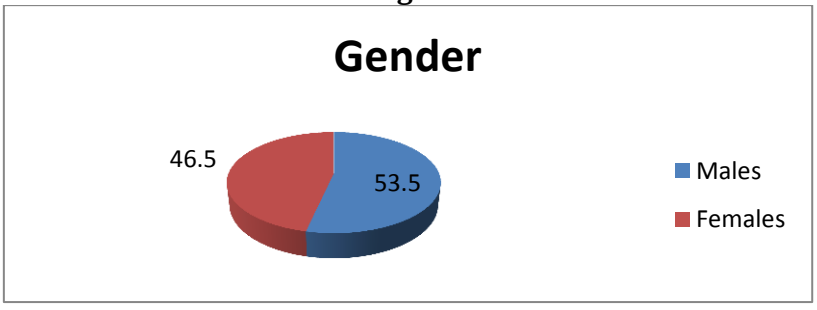

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Figure – 2: Distribution of cases based on the duration of diabetes

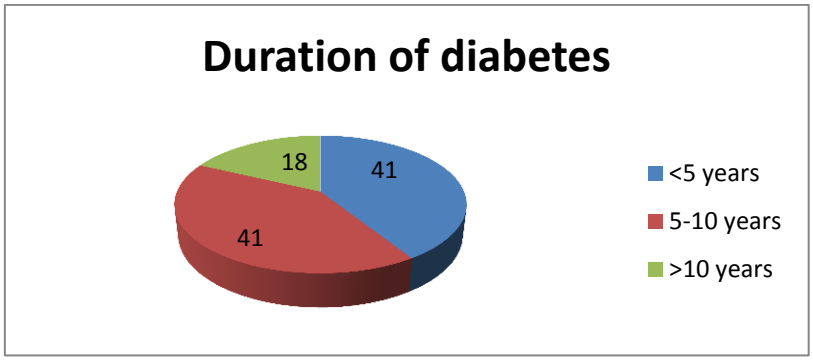

Table- 2: Distribution of cases according to random blood glucose

RBS	Frequency(n=200)	Percentage
<200	32	16.0
>200	168	84.0

Figure – 3: Distribution of cases based on ulcer site and number of ulcers

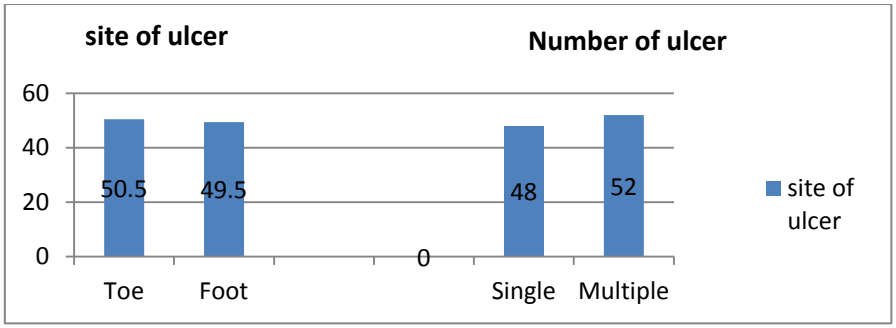

Table – 3: DUSS score in study participants

DUSS Score	Frequency(n=200)	Percentage
0	57	28.5
1	53	26.5
2	44	22.0
3	31	15.5
4	15	7.5

Table – 4: Association between DUSS score and primary healing

Primary healing	DUSS Score									
	0(n=57)		1(n=53)		2(n=44)		3(n=31)		4(n=15)	
	n	%	N	%	n	%	N	%	n	%
No	0	0	4	7.5	24	54.5	31	100.0	15	100.0
Yes (n=126)	57	100.0	49	92.5	20	45.5	0	0	0	0
χ^2	**137.4**									
Pvalue	**0.001**									

Table – 5: Association between DUSS score and plastic surgery

Plastic surgery	DUSS Score									
	0(n=57)		1(n=53)		2(n=44)		3(n=31)		4(n=15)	
	n	%	N	%	n	%	n	%	n	%

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No	57	100.0	49	92.5	28	63.6	22	71.0	15	100.0
SSG (n=27)	0	0	4	7.5	15	34.1	8	25.8	0	0
Flap(n=2)	0	0	0	0	1	2.3	1	3.2	0	0
χ^2	**37.2**									
P value	**0.001**									

Table – 6: Association between DUSS score and minor amputation

Minor amputation	**DUSS Score**									
	0(n=57)		**1(n=53)**		**2(n=44)**		**3(n=31)**		**4(n=15)**	
	n	**%**	**N**	**%**	**n**	**%**	**N**	**%**	**n**	**%**
No	57	100.0	53	100.0	36	81.8	11	35.5	10	66.7
Partial toe (n=1)	0	0	0	0	1	2.3	0	0	0	0
Toe (n=22)	0	0	0	0	7	15.9	15	48.4	0	0
Forefoot (n=10)	0	0	0	0	0	0	5	16.1	5	33.3
χ^2	**109.78**									
Pvalue	**0.001**									

Table – 7: Association between DUSS score and major amputation

Major amputation	**DUSS Score**									
	0(n=57)		**1(n=53)**		**2(n=44)**		**3(n=31)**		**4(n=15)**	
	n	**%**	**N**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
No	57	100.0	53	100.0	44	100.0	29	93.5	6	40.0
Below knee (n=9)	0	0	0	0	0	0	2	6.5	7	46.7
Above knee (n=2)	0	0	0	0	0	0	0	0	2	13.3
χ^2	**96.34**									
P value	**0.001**									

Table – 8: Correlation of DUSS score with healing time

R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**F**	**Sig.**
0.756	0.571	0.569	0.827	264.075	0.0001

Table – 9: Determining the diagnostic accuracy of DUSS score for clinical outcome

Outcome	**Area**	**Std. Error**	**P value**	**95% Confidence Interval**		**Cutoff**	**Sensitivity**	**Specificity**
				Lower Bound	**Upper Bound**			
Minor amputation	0.883	0.024	0.0001	0.836	0.929	1.50	100	65.9
Major amputation	0.967	0.015	0.0001	0.937	0.997	1.50	100	58.2
Amputation	0.949	0.015	0.0001	0.920	0.978	1.50	100	70.5
Non healing	0.955	0.013	0.0001	0.930	0.981	1.50	94.6	84.1

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Discussion

Advancing age is a non-modifiable risk factor for diabetes. In our study, mean age of patients presenting with diabetic foot ulcer was 49.74±9.78 years. Increase in risk of diabetic ulcer in patients with advancing age could be due to prolonged duration of diabetes and poorglycemic control increasing the risk of diabetic complications. The prevalence of diabetic foot ulcer has been reported to be higher in males as compared to females.[7] We observed diabetic ulcers to be slightly more common amongst males(53.5%), as compared to females although the clinical outcome was not significant. The findings of present study were supported by the findings of *Shashikiran* NJ et al (2013)[8] in which majority of patients with diabetic ulcer belonged to age range of 35 to 50 years and mean age of patients was 52.44±13.65 years with 56.7% cases being males. The gender composition of patients with diabetic ulcer in a study of *Harindranath* HR et al (2015)[9] was similar to present study where males outnumbered females, however, the mean age of patients was much higher (62 years) as compared to our study. *Sharma* M et al (2014)[10]conducted a study on 100 cases with diabetic foot ulcer, about 68% cases were males and mean age of patients was 70 years, which was much higher as compared to present study.

In our study, duration of diabetes was more than 5 years in majority of the cases with mean duration around 8 years. Random blood glucose was above 200 in 84% cases with mean of 267.9±58.0 mg/dl, and only 73% cases with diabetic foot ulcers were taking treatment. Duration of diabetes of more than 10 years is identified as an important risk factor for development of diabetic foot ulcer.[27] Mean duration of diabetes in a study of *Saraswat* B et al (2021)[11] was 7.61±5.72 years.[49] Duration of diabetes was more than 6 years in 58 out of 90 cases in a study of *Nandihalli* S et al (2021).[12]*Almobarak* AO et al(2017)[13]in their study reported a significant association of diabetic foot ulcer with duration of diabetes. However, mean duration of diabetes in a study of *Ndosi* M et al(2017)[14]were17.2years.

Diabetic Ulcer Severity Score (DUSS) has been introduced recently for assessing theseverity of foot ulcer and is based upon four clinical parameters. In our study, 48% cases had ulcers which were single in number while 52% cases had multiple ulcers. Ulcers were confined to toes in 50.5% of cases and in rest 49.5% there was involvement of proximal foot. Pedal pulses were not palpable in 19% cases and probing to bone was observed in 26% cases. Based upon these variables, DUSS score was calculated and median DUSS score was 1 (IQR-0-2). Out of 200 patients, DUSS score of 0,1,2,3 & 4 was noted in 28.5%, 26.5%, 22%, 15.5% and 7.5% of cases respectively. In a study of *Shashikiran* NJ et al (2013),[8] DUSS score in majority of cases was 3 followed by score of 2 and median DUSS score was found to be 2.00 (IQR= 2 to 3). In another study of *Sharma* M et al (2014),[10] DUSS score of 0 was found in 36% cases whereas the score of 1 and 4 was noted in 23% cases each. *Harindranath* HR et al (2015)[9] conducted a study on 226 patients with diabetic ulcer and majority of cases had DUSS score of 0 (n=87), followed by 51 and 43 cases with DUSS score of 1 and 4. *Balaji* V et al (2016)[15] conducted a study on 150 patients with diabetic ulcer and majority i.e., 44 and 46 cases had DUSS score of 0 and 1 respectively. In a study of *Kumar* ST et al (2016),[16] peripheral pulses could not be palpated in 24 cases, whereas probing to bone was positive in 43 cases; majority of patients had DUSS score of 1 (44%), followed by DUSS score of 2 (21%). Majority of cases in a study of *Shashikala* CK et al (2017)[17] had DUSS score of 2 followed by Score 3.

Clinical outcome was assessed in terms of primary healing, need of debridement, need for plastic surgery leading to healing, amputations (major/minor) and overall healing time. In our study, primary healing of wound with or without debridement but without any plastic surgical intervention was seen in 63% of cases. All the patients with DUSS score of 0 had primary healing(100%) closely followed by 92.5% of patients with score of 1. In contrast, only 45.5%

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of patients with score of 2 had primary healing, and none of the patients with DUSS score 3 and 4 had primary healing. This indicates that higher scores are associated with need for surgical management of ulcers as many cellular, metabolic, biochemical factors and microvascular disease contribute to altered tissue repair in DM. In our study surgical debridement was required in 124 (62%) cases and it was done in significantly higher proportions of cases with higher DUSS score ($p<0.05$) including 93.5% cases of DUSS score 3 and 100% cases of DUSS score 4. Debridement of diabetic foot ulcers is an important initial step in the management of the wound. Several benefits can result from proper debridement including removal of the necrotic and non- viable tissues and keeping a healthy granular wound bed. It also stimulates the release of growth factors to promote advancing healing edges. Not all ulcers can achieve complete healing, therefore additional treatment with skin grafting and tissue replacement can promote complete wound closure by reconstructing the skin defect. It reduces healing time and the length of hospital stay as compared to conservative dressings. STSG in diabetic foot ulcers poses several unique concerns including the presence of neuropathy, endothelial dysfunction and increased susceptibility to infection coupled with patient specific factors namely smoking, poor nutrition and poor compliance, making the care of chronic diabetic wounds challenging. For successful STSG, wound preparation is done adequately until a healthy granular base is present and all non-viable or infected tissues are removed.

Plastic surgery was done in significantly higher proportions of cases with DUSS score2 (36.4%) and DUSS score 3 (29%) ($p<0.05$). Cases with DUSS score 0 healed wellwithout the need for plastic surgery. Few of the cases with DUSS score 1 (7.5%)required SSG because of the large surface area of ulcer and prolonged healing time in primary healing could be reduced by plastic surgery intervention. In our study total 22% cases underwent amputation. Majority of minor amputations were seen in cases of DUSS score 3 (20/34) and few cases with DUSS score 2 (8/34).DUSS score of 4 was associated with majority of major amputations. The presence of large and multiple ulcers with bone probing and osteomyelitis should be assessed for arterial ischemia and ischemic neuropathy. Overall mean healing time was also found to be significantly higher in patients with higher DUSS score ($p<0.05$), with a significant positive strong correlation of DUSS score with prolonged healing time($r=0.756$, $p<0.05$). DUSS score 0 had a healing time of around 22 days while for DUSS score 1, it was around 33 days. DUSS score 2,3,4 had significant increase in healing time of around 52 days, 72 days, and 84 days respectively.

The findings of present study were also concordant to the findings of *Balaji* V et al (2016)[15] where majority of cases with DUSS score of 0-2 healed with primary intention whereas majority of cases with DUSS score of 3 and 4 required amputation ($P<0.001$). Our study findings were concordant with the findings of *Kumar* ST et al (2016),[16] in which higher DUSS score was significantly associated with adverse clinical outcome in terms of higher rate of amputation ($P<0.05$). *Shashikala* CK et al (2017)[17] reported the rate of amputation as 50% and of them, major and minor amputation was done in 25% cases each. The probability of healing decreased significantly with increase in DUSS score. The findings of present study were also supported by the findings of *Menezes* JV et al (2019)[18] in which the area under the curve was 0.744 for predicting the outcome, showing DUSS score to be a significant predictor of amputation and healing.

Conclusion

DUSS scoring system is a simple prognostic tool based on bed side clinical examination without the need of any investigation to determine the probability of healing and limb salvage. It is easy to apply, reliable and valid method for determining the severity of diabetic foot ulcer and helps in optimizing the clinical approach. The diagnostic accuracy of DUSS

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score is highest for determining the risk of major amputation, followed by the risk of non-healing as per ROC curve. Advancing age, duration of diabetes and untreated/improper treatment of diabetes mellitus are predictors of high DUSS score that is linked with poor clinical outcome in terms of need of debridement, plastic surgery and amputation. Hence, DUSS score can be apart of day-to-day practice in diabetic clinics to classify the ulcers early and plan the management of patients according to the predicted clinical outcome.

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