

ORIGINAL ARTICLE

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Pilot testing the new Amit Jain's scoring system for diabetic foot ulcer in predicting the risk of amputation

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Abstract

The aim of this study was to test the new Amit Jain's diabetic foot ulcer scoring and determine the predictive validity of this simple scoring for amputation in diabetic foot ulcers. This newly derived score was applied to the above authors' study that was previously done on 54 patients with diabetic foot ulcer. The mean Amit Jain's scoring (AJ Scoring) was 5.31 ± 1.37 . Majority of the patients were in moderate risk category. 33.33% had amputation. Significant association ($P=0.02$) was noted with Amit Jain's increasing score and amputation. Patients who had major amputation were in high-risk category group ($P=0.006$). The odds ratio for major amputation category was 3.39. This newly derived Amit Jain's diabetic foot ulcer score is simple, easy to remember score that is an excellent predictor of amputation. Further studies are needed to know its predictive ability for healing of the ulcer.

Keywords: Diabetic foot, ulcer, Amit Jain's, scoring, classification, amputation

Introduction

Diabetes is a major health problem globally and it is believed that there were 425 million people affected by diabetes mellitus in 2017 and it is going to affect 628 million by year 2045 [1]. There are various complications of diabetes and one such disabling complication is diabetic foot ulcer. Around 15% of patients affected with diabetes mellitus are likely to get an ulcer during their lifetime and 15% of the foot ulcers will result in amputation [2, 3].

There have been various classifications for diabetic foot ulcers with many having scores to predict a particular outcome and some of them are Meggitt-Wagner classification, Texas classification, SINBAD system, PEDIS system, Amit Jain's diabetic foot ulcer classification, DUSS classification, etc [4-6]. Each has their own advantages and demerits.

Amit Jain's diabetic foot ulcer classification proposed in 2014 from India, is a new classification that divided the ulcers into 3 classes (Table 1). This descriptive classification later had a 'SAC' coding system where 'S' refers to size, 'A' refers to anatomical region involved and 'C' refers to class of ulcer and is governed by law of coding [7]. Recently, this classification was given a simple scoring system [8].

The aim of this study is to determine the predictive ability of this newly derived score for amputation in foot.

Table 1. Amit Jain's diabetic foot ulcer classification

Amit Jain's Class of Diabetic Foot Ulcers	Description	Examples
Class 1 Diabetic Foot Ulcers	Simple Ulcer	Trophic Ulcer
Class 2 Diabetic Foot Ulcers	Complex Ulcers	Ischemic Ulcer, Claw Toe Ulcers, Charcot Foot Ulcer, Etc
Class 3 Diabetic Foot Ulcers	Complicated Ulcers	When Class 1 or 2 Get Infected Example – Infected Trophic Ulcer

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Material and Methods

The association of gender, ulcer size, location, presence of osteomyelitis, peripheral arterial disease and the class of ulcer with amputation was reported in a study of 54 patients by us [9]. A new diabetic foot ulcer score was subsequently derived. In this score, the 3 parameters were scored as follows: 1) Size (less than 2cm – 1, 2-4 cm as 2 and more than 4 cm as 3, 2] Anatomical area affected (forefoot as 1, midfoot as 2 and hindfoot as 3, 3] Amit Jain's class of ulcer (Class 1 as 1, class 2 as 2 and class 3 as 3 (Table 2).

Table 2. The new Amit Jain's scoring for diabetic foot ulcer. Maximum Score is 9.

Score	Size	Anatomical region	Class of ulcer
1	Less than 2 cm	Forefoot	Simple ulcer
2	2-4 cm	Midfoot	Complex ulcer
3	> 4 cm	Hindfoot	Complicated ulcer

We then looked into the association of this newly derived score with amputation in the above population of patients [9]. The Institutional ethics committee approval was obtained for this study (RRMCH-IEC/20/2020-21).

Statistical analysis

Descriptive statistics were reported using mean and SD for the normally distributed continuous variables, for the variables that are not normally distributed were median with 25th and 75th percentiles. Categorical variables were reported as number and percentage. Chi-square test or Fisher's exact test was used to test the association between amputation done and major amputation with clinical characteristics. Independent t test was used to compare the Amit Jain's (AJ) scoring by amputation done with not done categories and major amputation done and not done categories.

Logistic regression was performed to assess the risk for amputation and major amputation. The discriminative power of the prediction of score was assessed by calculating the area under the receiver operating characteristic (ROC) curves (AUC). Sensitivity, specificity, positive predictive and negative predictive values were reported. P value less than 0.05 was considered statistically significant. All the analysis was performed using SPSS version 25.0 (IBM Corp-2017, Armonk, NY)

Results

The data from the above 54 patients, with a mean age of 58.7 ± 12.6 years, were used to study this new score and analyze the outcome, amputation. 75.9% were males and 24.1% were females. 57.4% of these patients had diabetes of 10-20 years duration and 53.7% had comorbidities like hypertension, ischemic heart disease, etc [9]. 88.8% had ulcer in their forefoot with commonest class being class 3 diabetic foot ulcer (72.2%). These patients had underlying osteomyelitis in 20.4% and peripheral arterial disease in 7.4% [9].

When we tested this new ulcer score, it was seen that the mean Amit Jain's (AJ) scoring was 5.31 ± 1.37 . Twelve patients (22.2%) had a low risk category, 61.1% and 16.7% had moderate risk and high

risk categories respectively. A total of 18 patients (33.33%) had amputation in the study (2 major and 16 minor). Table 3 describes the association of clinical characteristics with Amit Jain's scoring. There was no significant difference in the mean age and duration of DM between the AJ risk categories.

Figure 1 shows the box plot for Amit Jain's scoring across amputation, major and minor amputation. It was noted that the mean AJ scoring was significantly higher ($P=0.02$) among amputation done (5.89 ± 0.90) group as compared to amputation had not done (5.00 ± 1.48). Among major amputation done group, the mean AJ scoring was 7.50 ± 0.70 which was significantly higher ($P=0.02$) as compared to major amputation had not done group (5.23 ± 1.32). Association between AJ risk categories with amputation, major and minor amputation done categories is represented in Table 4. There was a significant association observed between amputation parameters with AJ risk categories. Among patients who had amputation done was predominantly associated with moderate to high risk categories ($P=0.02$). Patients who had major amputation done was significantly associated with high risk category ($p=0.006$). Logistic regression was performed to find the increased odds of being in amputation done category for an increased AJ scoring. It was observed that for a unit increase in AJ scoring, the patient were 1.65 times more likely to be associated with amputation done category (Odds ratio: 1.65, 95% C.I=1.03 -2.62, $P=0.03$) and for major amputation category the odds ratio was 3.39 (95% C.I=0.98–11.76, $P=0.05$).

Table 5 provides the sensitivity, specificity, positive predictive (PPV) and negative predictive values (NPV). Figure 2a and 2b depicts the ROC for AJ scores on amputation done and major amputation done categories. Based on the ROC curve analysis, the AJ score achieved AUC of 0.71 for patients with amputation done (Figure 2). The predictive validity of this scoring system shows that the AJ score of 5 (AUC of the ROC was 0.714) can predict amputation ($P=0.001$) and is clinically useful. The optimal cutoff point for major amputation category was noted to be a score of 7 with an AUC of 0.93, indicating a good diagnostic accuracy of AJ scoring (Figure 3).

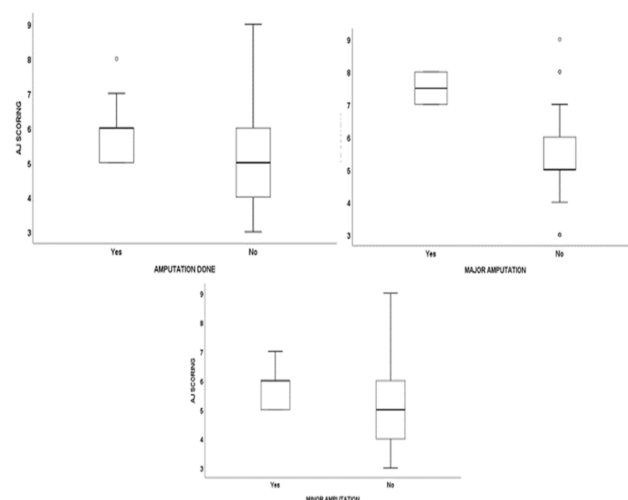


Figure 1. Box plot showing the comparison of AJ scoring by amputation, major and minor amputation

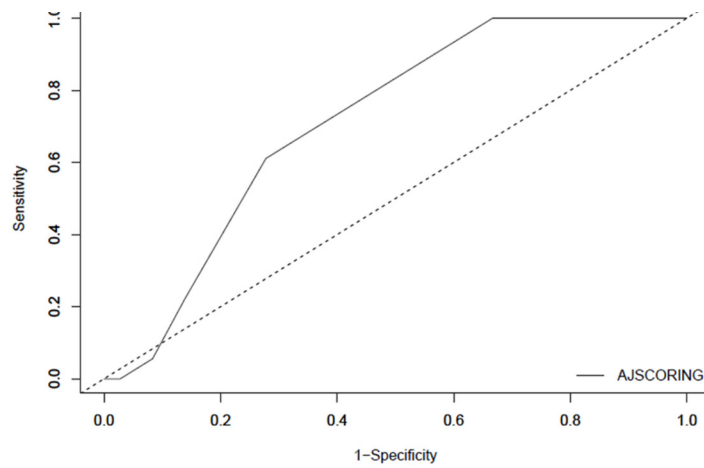


Figure 2. Receiver operating characteristic (ROC) curve for AJ scoring for amputation done group (AUC of 0.71)

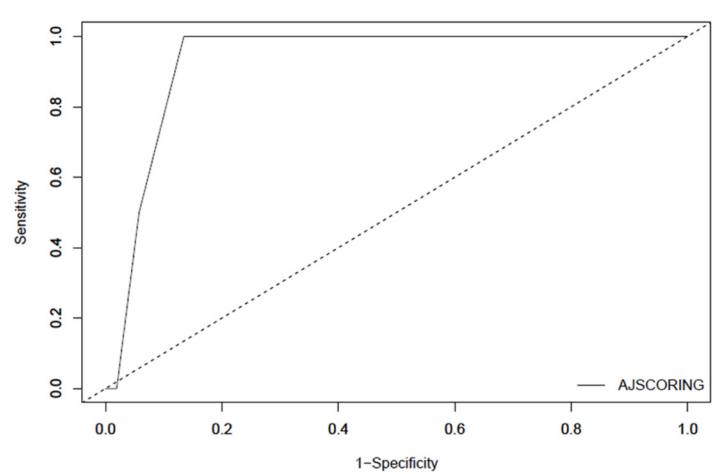


Figure 3. Receiver operating characteristic (ROC) curve for AJ scoring for major amputation done group (AUC of 0.93).

Table 3. Comparison of clinical characteristics by Amit Jain's score category

Variables	Low risk (score 3 to 4)	Moderate (Score 5 to 6)	High Risk (Score 7 & above)	P value
Age	60.0±15.2	59.2±13.2	55.3±5.74	0.672
Duration of Diabetes mellitus	12.8±6.81	13.9±8.66	12.6±7.17	0.858
Sex				
Male	7 (58.3)	26 (78.8)	8 (88.9)	0.222
Female	5 (41.70)	7 (21.2)	1 (11.1)	
Side of foot				
Right	8 (66.7)	22 (66.7)	4 (44.4)	0.615
Left	2 (16.7)	8 (24.2)	4 (44.4)	
Bilateral	2 (16.7)	3 (9.1)	1 (11.1)	
Co morbidities				
Yes	6 (50.0)	18 (54.5)	5 (55.6)	0.957
No	6 (50.0)	15 (45.5)	4 (44.4)	
Hypertension				
Yes	5 (41.7)	18 (54.5)	3 (33.3)	0.464
No	7 (58.3)	15 (45.5)	6 (66.7)	
Toes involved				
Yes	5 (41.7)	22 (66.7)	3 (33.3)	0.111
No	7 (58.3)	11 (33.3)	6 (66.7)	

Table 4. Association of Amit Jain's score category with amputation done, major and minor amputation

Variables	Low risk	Moderate	High Risk	P value
Amputation (Minor+Major)				
Done	0	14 (77.8)	4 (22.2)	0.021
Not done	12 (33.3)	19 (52.8)	5 (13.9)	
Major Amputation				
Done	0	0	2 (100)	0.006
Not done	12 (23.1)	33 (63.5)	1 (13.5)	
Minor Amputation				
Done	0	14 (87.5)	2 (12.5)	0.019
Not done	12 (31.6)	19 (50.0)	7 (18.4)	

Table 5. Predictive ability of Amit Jain's scoring for diabetic foot ulcer

Amit Jain's scoring	Sensitivity	Specificity	PPV	NPV
Amputation	100	33	43	100
Major amputation	100	87	22	100
Minor amputation	100	32	38	100



Figure 4. Right great toe trophic ulcer. This is class 1 diabetic foot ulcer as there is no structural visible bony deformity and pulses are good. As per coding it is Amit Jain's S2A1C1. The total score is 4 and patient belongs to low risk group for amputation

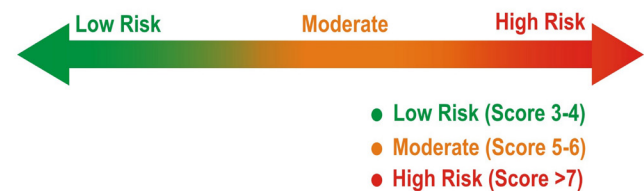


Figure 5. The risk groups as per Amit Jain's ulcer scoring system for diabetic foot

Discussion

A myriad of scoring system were proposed in diabetic foot over past 3 to 4 decades with purpose of predicting outcomes ranging from healing to amputation and only few had undergone validation [10]. A few scoring system in diabetic foot ulcer, though validated, often have many parameters that are difficult to remember [6, 10]. Further, it parameters had more scores in it, then such scoring system often end up for research purposes rather than to be used in clinical practice.

We believe that this new scoring system, that just has 3 parameters, would be very easy to remember and could be used in clinical practice.

This new ulcer classification, which is a focal classification proposed in 2014 from Indian subcontinent, has 3 simple classes of ulcers namely, simple, complex and complicated ulcers. In class 1 ulcers (simple), there is no intrinsic cause for non-healing of the ulcers. Example in this category is a trophic ulcer (Figure 4). They often heal with regular dressings and pressure mitigation (9). In class 2 ulcers (complex), there is some intrinsic cause for non-healing like bony deformities and ischemia. Correction of them is required to achieve healing of the wounds. In class 3 ulcers (complicated), the class 1 or the class 2 gets infected and may have associated cellulitis, abscess or osteomyelitis [5, 9]. They require surgical debridement or removal of affected bones as first priority followed by dressings, offloading and correcting the intrinsic cause (9). From the above class, this new score was derived and it is categorized into 3 risk group namely, low risk (score 3 & 4), moderate risk (score 5 & 6) and high risk (score 7 and above) (Figure 5). Uniquely, with a descriptive classification for an ulcer in foot along with coding it like TNM staging system in oncology and also giving the diabetic foot ulcer, a scoring, resulted in the Amit Jain's triangle of diabetic foot ulcer classification, which serves an interesting teaching tool [8].

We could see in this study that with increase in the score, there was significant increase in the amputation and further, patients

who underwent major amputation were all in high risk category with a score of 7 and above.

Conclusion

The new Amit Jain's diabetic foot ulcer scoring showed a good sensitivity, specificity, positive predictive value, negative predictive value and area under the curve (AUC) values. This scoring showed a significant association with amputation (AJ score of 5 and above) and higher scores were associated with major amputation (AJ Score of 7 and above). This new simple, easy to remember scoring system is a good predictor of amputation and future studies are needed to know its association with healing outcomes.

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Conflict of interests

The authors declare that they have no competing interests.

Financial Disclosure

All authors declare no financial support.

Ethical approval

Ethical approval was taken for this study (RRMCH-IEC/20/2020-21).

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