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ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2020;9(4):982-7

Study of toe deformities in diabetic foot through Amit Jain's extended 'SCC' classification

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Received 20 June 2020; Accepted 19 August 2020
Available online 20.11.2020 with doi: 10.5455/medscience.2020.06.120

Abstract
A study was conducted to analyze the visible named toe deformities that occur in foot of patients with diabetes through the new Amit Jain's extended 'SCC' classification. A total of 27 patients were included who fulfilled the criteria. Majority of the patients (59.3%) were males. 11.1% of patients had diabetes of more than 24 years duration. Type 1 toe deformities were the most common deformities seen in 85.2% of the cases. Hammer toe was the commonest pathological type followed by claw toes. Around 14.8% had underlying callus/ulcers (complex deformity). This new classification is simple and easy to use in clinical practice.

Keywords: Diabetes, foot, toes, ulcer, Amit Jain, deformity

Introduction

Diabetes mellitus, a chronic non-communicable disease, has affected around 450 million people worldwide [1]. One such known complication of diabetes is diabetic foot which is increasing worldwide. Ulcers are one such common lesion that is associated with long healing period and adds to financial burden of the patient [2]. It is believed that around 5% of diabetes patients can develop ulcers annually [3]. Bacterial invasion in these ulcers can lead to infection and amputation [4]. It is known that more than half of these ulcers will get infected and 10-30% of them will progress to an amputation in lower extremity [3, 5].

The known risk factors for diabetic foot ulcers are neuropathy, ischemia, foot deformities, trauma, previous ulceration/amputation in foot, etc. [6, 7]. The foot deformities that occur in diabetic foot are hammer toes, claw toes, mallet toes, pes cavus, prominent metatarsal heads, Charcot foot, etc [2, 7, 8]. It is believed that the prevalence of these deformities differ in different zones and countries [9].

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The aim of our study was to analyze the visible named toe deformities (structural) seen in diabetic foot through the new Amit Jain's extended "SCC" classification [Figure 1] for diabetic foot [10]. The Amit Jain's extended 'SCC' classification divides the toe deformities into 3 types [Table 1].

The toe deformities without ulcer/callus are type 1 deformities (simple), those with callus/ulcer are type 2 deformities (complex) and toe deformities with infection are complicated deformities [10]. This is a simple, practical and easy to remember classification which also provides treatment guideline.

Table 1. Amit Jain's 'SCC' classification for toe deformities with treatment guidelines.

Type of Toe Deformities	Description	Characteristics	Treatment guidelines
Type 1 Toe Deformities	Simple Deformity	Deformity without ulcer	Splints, Toe caps, Diabetic footwear's, etc
Type 2 Toe Deformities	Complex Deformity	Deformity with ulcer/callus	Cleaning & Dressing, debridement, corrective surgeries like Tenotomy, Arthroplasty, etc, Offloading, Diabetic footwear's
Type 3 Toe Deformities	Complicated Deformity	Deformity with infection (Infected ulcer, abscess, etc)	Surgeries like debridement, resection of infected bone, etc, Cleaning & Dressing, Antibiotics, Offloading, Diabetic footwear's

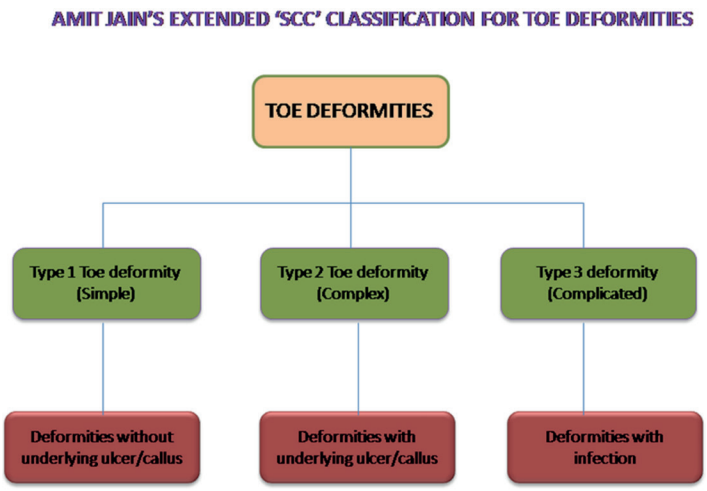

Figure 1 showing the Amit Jain's extended "SCC" classification for toe deformities for diabetic foot

Material and Methods

A descriptive retrospective analysis was done at Amit Jain's Institute of Diabetic Foot and Wound Care, Brindhavvan Areion Hospital, Bengaluru, India. The study period was from December 2018 to November 2019. The study was approved by an Institutional ethics committee (RRMCH-IEC/172/2019-20).

The following were inclusion and exclusion criteria

Inclusion criteria

1)All visible named toe deformities (structural) seen in all the new diabetic foot patients who presented to us during the above period for foot related problems

Exclusion criteria

1) Unnamed toe deformities
2) Patients who underwent surgeries on forefoot earlier after which they developed deformities
3) Patients seen in other departments/other specialist
4) Functional toe deformities
5) Congenital toe deformities in diabetic patients

Data Analysis

Data was analyzed using statistical software SPSS 22.0 and R environment ver.3.2.2. Microsoft word and excel were used to generate graphs and tables. Both descriptive and inferential statistics were carried out in the study. Results on continuous measurements were presented on Mean ±SD (Min-Max) and results on categorical measurements were presented in number (%). Significance was assessed at 5% level of significance. [11-13]

The following assumption on data is made

- Dependent variables should be normally distributed
- Samples drawn from the population should be random
- Cases of the samples should be independent

Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, Non-parametric setting for Qualitative data analysis. Fisher exact test was used when samples were very small.

Significant Figures

+ Suggestive significance (P value: 0.05 <P <0.10)
* Moderately significant (P value: 0.01 <P 0.05)
** Strongly significant (P value: P ≤0.01).

Results

A total of 27 patients were included in this study. Mean Age was 61.85± 8.09 years (Table 2). 16 patients (59.3%) were males and 11 patients (40.7%) were females (Figure 2).

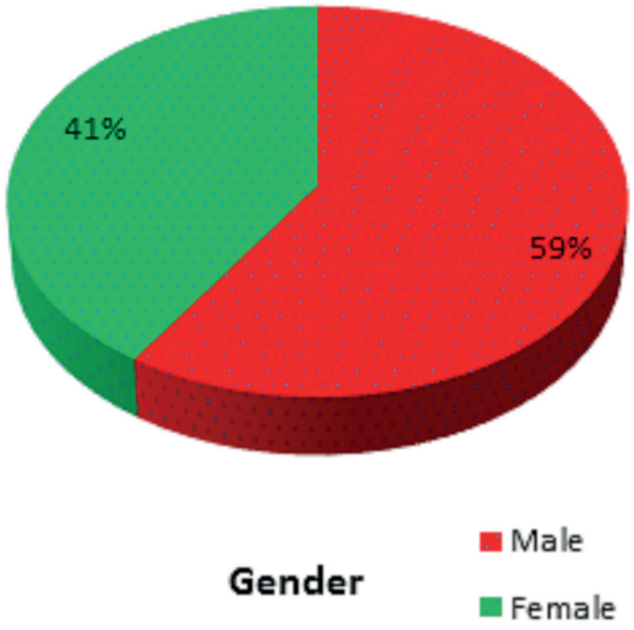

Figure 2. Showing gender distribution

Table 2. Showing age distribution of patients studied

Age in years	Number	Percentages
<50	2	7.4
50-60	10	37.0
61-70	12	44.4
>70	3	11.1
Total	27	100.0

Majority of the patients (48.1%) had diabetes of 12 -24 years with 40.7% having diabetes of less than 12 years and 11.1% having diabetes of more than 24 years (Figure 3). All the patients had peripheral neuropathy.

Around 9.3% had hypertension, 11.1% had ischemic heart disease (IHD) and 29.6% had no co-morbidities (Figure 4).

Majority of the patients (85.2%) had type 1 (Simple) toe deformity followed by 14.8% having type 2 deformity (Complex). None of the patients had type 3 deformities (Table 3).

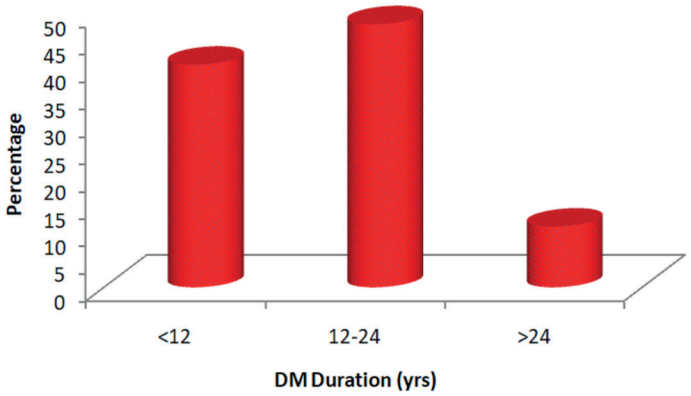

Figure 3. Showing distribution of diabetes mellitus (DM) duration

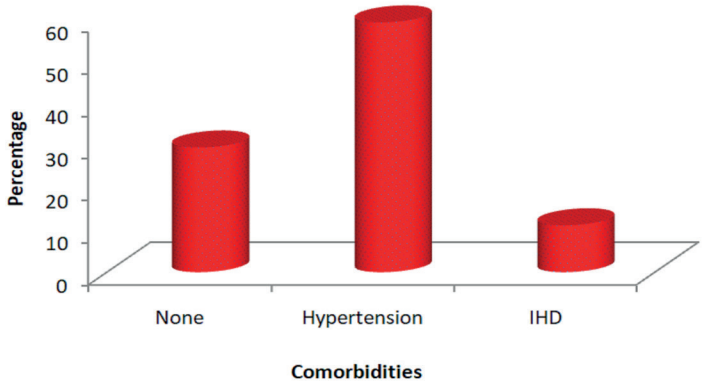

Figure 4. Showing co-morbidities distribution of patients studied

Table 3. Showing distribution of patients according to Amit Jain's classification for toe deformities

Amit Jain's classification	Number	Percentages
Type 1(Simple deformity)	23	85.2
Type 2 (Complex deformity)	4	14.8
Type 3 (Complicated Deformity)	0	0
Total	27	100.0

There was no association of age, gender, diabetes duration, co-morbidities, side of foot, number of deformities (single/multiple), pathological type of deformity or presence of peripheral vascular disease (PVD) with type of deformities (Table 4).

There was no association between diabetes duration, co-morbidities, side of foot, number of deformities (single/multiple), peripheral vascular disease or gender with pathological varieties of deformities (Table5). Hallux valgus and mallet toe often occurs as single deformity in each foot (Figure 5)

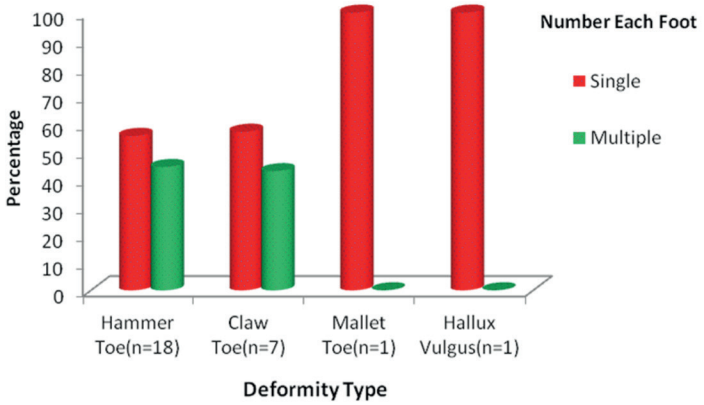

Figure 5. Showing relation of number of toe deformities in each foot with pathological type

Discussion

The deformities that occur in diabetic foot can affect forefoot, midfoot or hindfoot, either in isolation or in combination. Various mechanisms have been stated for these deformities and they include intrinsic muscle atrophy, ill-fitting footwear, etc [14].

Toe deformities are commonly seen forefoot deformities in clinical practice. These toe deformities could be structural like claw toe/ hammer toe or they could be functional like hallux rigidus [7]. These deformities lead to abnormal high pressure at certain areas where callosities will develop [15]. With repetitive pressures at these areas, tissue breakdown is likely to occur resulting in ulcers [15].

Often, different studies have shown different varieties of foot deformities to be common in their region. In Ababneh et al series [16], hallux valgus (17.4%) was more common than claw/hammer toes (16%). Their series had 2.1% patients having Charcot foot. In Ogbera et al series [17], prominent metatarsal head (12.8%) was most common foot deformity. In their series [17], claw toes (7.4%) were more common than hallux valgus (6.3%). In Mansour et al series [18], prominent metatarsal heads (36.2%) was the commonest structural foot abnormality. Hammer toes in their series accounted for 10.9% and claw toes (3.8%).

85.2% of the toe deformities in this study belonged to type 1 deformities. Although our series focused only on structural toe deformities, hammer toes (Figure 6) was found to be commonest deformity followed by claw toes.The prevalence of hallux valgus was very less in our series.

Figure 6. Showing hammer toe. This is type 1 deformity as per Amit Jain's classification

The reason for hallux valgus being more common in some countries is due to usage of high heels and also shoes with narrow toe box [19]. In south Asian countries like India, majority of patients have habit of using toe grip footwear. It is believed that the intrinsic muscles play an important function to grip the footwear between the first and the second toes [20]. In diabetic foot motor neuropathy where the function of these muscles is distorted, there is high chances for toes to undergo hammer/clawing to grip the footwear.

The foot deformities results in callus formation due to high pressures and subsequently ulcer formation. In our study, only 14.8% had underlying callus/ulcers (complex deformity). Often, they were treated by us through offloading and tenotomies.

This simple classification would henceforth help clinician to easily place the toe deformities in one of the 3 categories. The type 1 toe deformities in diabetic foot usually can be managed conservatively and should not be subjected to unnecessary surgeries.

The limitation in our study is that our sample size was small and further we concentrated only on structural toe deformities.

Table 4. Showing association of baseline clinical variables according to classification of patients studied

Variables	Amit Jain's Classification		Total (n=27)	P value
	Type 1 (Simple deformity) (n=23)	Type 2 (Complex deformity) (n=4)		
Age in years				
<50	1(4.3%)	1(25%)	2(7.4%)	0.281
50-60	9(39.1%)	1(25%)	10(37%)	
61-70	11(47.8%)	1(25%)	12(44.4%)	
>70	2(8.7%)	1(25%)	3(11.1%)	
Gender				
Male	13(56.5%)	3(75%)	16(59.3%)	0.624
Female	10(43.5%)	1(25%)	11(40.7%)	
DM Duration				
<12	10(43.5%)	1(25%)	11(40.7%)	0.576
12-24	11(47.8%)	2(50%)	13(48.1%)	
>24	2(8.7%)	1(25%)	3(11.1%)	
Comorbidities				
None	6(26.1%)	2(50%)	8(29.6%)	0.745
Hypertension	14(60.9%)	2(50%)	16(59.3%)	
IHD	3(13%)	0(0%)	3(11.1%)	
Side				
Unilateral	13(56.5%)	4(100%)	17(63%)	0.264
Bilateral	10(43.5%)	0(0%)	10(37%)	
Single/multiple deformities				
Single	13(56.5%)	3(75%)	16(59.3%)	0.624
Multiple	10(43.5%)	1(25%)	11(40.7%)	
Pathological type of Deformity				
Hammer toe	16(69.6%)	2(50%)	18(66.7%)	0.317
Claw toe	6(26.1%)	1(25%)	7(25.9%)	
Mallet toe	1(4.3%)	0(0%)	1(3.7%)	
Hallux vulgus	0(0%)	1(25%)	1(3.7%)	
PVD				
Yes	3(13%)	0(0%)	3(11.1%)	1.000
No	20(87%)	4(100%)	24(88.9%)	

Table 5. Showing association of clinical variables in relation to pathological types of deformities in patients studied

Variables	Pathological Types of Deformity				Total (n=27)	P value
	Hammer Toe (n=18)	Claw Toe (n=7)	Mallet Toe (n=1)	Hallux Vulgus (n=1)		
DM Duration						
<12	5(27.8%)	4(57.1%)	1(100%)	1(100%)	11(40.7%)	
12-24	10(55.6%)	3(42.9%)	0(0%)	0(0%)	13(48.1%)	0.449
>24	3(16.7%)	0(0%)	0(0%)	0(0%)	3(11.1%)	
Co-morbidities						
None	6(33.3%)	1(14.3%)	0(0%)	1(100%)	8(29.6%)	
Hypertension	11(61.1%)	4(57.1%)	1(100%)	0(0%)	16(59.3%)	0.385
IHD	1(5.6%)	2(28.6%)	0(0%)	0(0%)	3(11.1%)	
Classification						
Simple deformity	16(88.9%)	6(85.7%)	1(100%)	0(0%)	23(85.2%)	0.317
Complex deformity	2(11.1%)	1(14.3%)	0(0%)	1(100%)	4(14.8%)	
Side						
Unilateral	10(55.6%)	6(85.7%)	0(0%)	1(100%)	17(63%)	0.283
Bilateral	8(44.4%)	1(14.3%)	1(100%)	0(0%)	10(37%)	
Single/multiple toe deformities						
Single	10(55.6%)	4(57.1%)	1(100%)	1(100%)	16(59.3%)	1.000
Multiple	8(44.4%)	3(42.9%)	0(0%)	0(0%)	11(40.7%)	
PVD						
Yes	2(11.1%)	1(14.3%)	0(0%)	0(0%)	3(11.1%)	1.000
No	16(88.9%)	6(85.7%)	1(100%)	1(100%)	24(88.9%)	
Gender						
Male	10(55.6%)	5(71.4%)	0(0%)	1(100%)	16(59.3%)	0.548
Female	8(44.4%)	2(28.6%)	1(100%)	0(0%)	11(40.7%)	

Conclusion

Foot deformities especially those involving forefoot, are common in clinical practice. Our study shows type 1 deformity are the commonest types seen in diabetic foot with hammer toe followed by claw toe being commonest pathological type. Hallux valgus prevalence was very low in our patients. Amit Jain's extended 'SCC' classification is a simple, practical and easy to remember classification that efficiently categorizes the toe deformities into 3 simple types and one can use them in their practice without difficulty.

Acknowledgement
The author would like to thank Dr KP Suresh, Scientist (Biostatistics), National Institute of Veterinary Epidemiology and Disease Informatics (NIVEDI), Bangalore, for reviewing the research methodology and statistical results of the study and to drax analytics and inferences (www.draxdata.com) team for analysis, interpretationand presentation of data.

Conflict of interests
The authors declare that they have no competing interest

Financial Disclosure
All authors declare no financial support.

Ethical approval
Local ethics committee approved (RRMCH-IEC/172/2019-20).

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