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Research Article

Analysis of Callus in Diabetic Foot through Amit Jain's Extended 'SCC' Classification

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Abstract: ***Aim*** – To study callus occurring in diabetic foot and distributing them through Amit Jain's extended 'SCC' classification. ***Methods & materials*** – A descriptive retrospective analysis was done at Amit Jain's Institute of Diabetic Foot & Wound Care at Brindhavvan Areion Hospital, Bengaluru, India. The study period was from December 2018 to November 2019. SPSS 22 was used for statistical analysis. ***Results*** – 30 patients were studied. Most of them were males and most were between 61-70 years old. Right foot was affected in 46.7%. All the cases of calluses were in forefoot in this study. Metatarsophalangeal joint was the most commonly affected site (50%). 53.3% of the callus was less than 2 cm in size. Type 1 callus was most common callus affecting 53.3% followed by type 2 callus. Type 3 callus were significantly multiple in number compared to type 1 and 2 callus. Antibiotics was used only for type callus as they had underlying infection. ***Conclusion***- Diabetic foot callus are common in clinical practice and they are common in older people. Type 1 callus are most commonly seen in this study. Amit Jain's classification is a new simple, easy, practical classification for callus which can effectively categorize all the calluses into any of the 3 types and it guides in treatment.

Keywords: Diabetes, foot, Callus, Amit Jain, Classification.

INTRODUCTION

It is well known that one of the distressing complications of diabetes is diabetic foot which is known to affect the quality of life of patients (VanNetten, J. J., *et al* 2018). It is believed that annual incidence of development of foot ulcers in diabetic patients is more than 2% and around 15% of ulcers results in amputation (VanNetten, J. J., *et al* 2018; Judge, M. 2014). Peripheral neuropathy, trauma and foot deformity are common cause of development of ulceration (Abouaesha, F., *et al*. 2001). Loss of sensation and biomechanical deformity that occurs in diabetic foot leads to increased plantar pressures (VanNetten, J. J., *et al* 2018; Abouaesha, F., *et al*. 2001; Shankhdhar, L. K., *et al*. 2013). If an average person takes 8000 to 10,000 steps per day (Garthwait, R. 2003), then one can imagine the microtrauma an insensate foot can undergo every day. It is also known that a foot has to sometime bear 150% of the body weight when ambulating that can increase when there is underlying deformity or obesity (Shankhdhar, L. K., *et al*. 2013). Increase in plantar pressures on the foot will lead to formation of callus (Jain, A. K. C., & Sabasse, M, 2015; Spink, M. J., *et al*. 2009). Callus formation are known to lead to foot ulcer due to excessive mechanical loading (Amemiya, A., *et al*. 2016).

In spite of being such a common entity, callus in diabetic foot have very few studies done on it especially from countries like India where the diabetic foot prevalence is extremely high. We aimed to conduct this study on callus in diabetic foot through the new Amit Jain's classification for callus (Figure 1), which is an extended "SCC" classification (Jain, A. K. C. 2019). According to this classification, calluses are divided into 3 types [Table 1]. The "SCC" classification in diabetic foot was developed by Amit Jain for diabetic foot ulcer (Jain, A. K. C. 2015; Jain, A. K. C., *et al*. 2018) and later applied to other entities like offloading, Charcot foot, therapeutic footwear, calluses etc (Jain, A. K. C. 2019; Jain, A. K. C., *et al*. 2019).

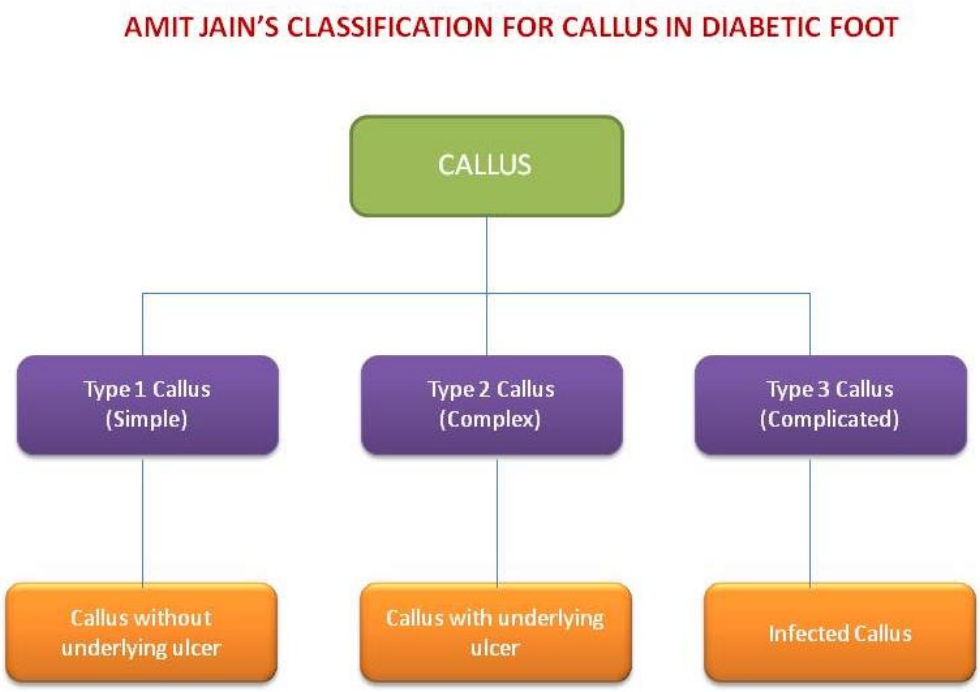

Figure 1 showing Amit Jain's classification for callus

TYPE OF CALLUS IN DIABETIC FOOT	DESCRIPTION	CLINICAL CHARACTERISTICS	TREATMENT GUIDELINES
Type 1 Callus	Simple Callus	Callus without underlying ulcer	Debridement, Cleaning & dressing, Diabetic footwear
Type 2 Callus	Complex Callus	Callus with underlying ulcer	Debridement, Cleaning & dressing, Offloading, Diabetic footwear (Corrective surgeries if callus frequently recurs)
Type 3 Callus	Complicated Callus	Infected callus	Debridement, Cleaning & Dressing, Antibiotics, Offloading, Diabetic footwear

Table 1 showing Amit Jain's extended 'SCC" classification for callus in diabetic foot

METHODS AND MATERIALS

A descriptive retrospective analysis was done at Amit Jain's Institute of Diabetic foot and Wound Care at Brindhavvan Areion Hospital, Bengaluru, India. The study period was for 1 year from December 2018 to November 2019. All the new patients who presented to our centre with callus in the diabetic foot were included in the study. Patients who refused treatment or treated by other surgeons in the hospital were excluded. An Institutional Ethics Committee clearance was obtained for this study (RRMCH-IEC-173/2019-20).

DATA ANALYSIS

(Rosner, B. 2000; Riffenburg, R. H. 2005; Rao, P. S. S. S., & Richard, J. 2006). 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. 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 30 patients were studied. 60% of them were males (Figure 2).

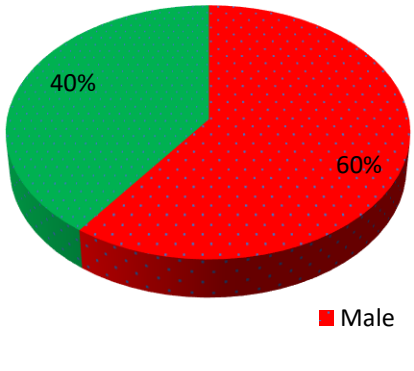

Figure 2: showing gender distribution

Most of the patients (33.3%) were between 61-70 years of age followed by 30% of them being in 51-60 years of age [Table 2].

Age in years	No. of patients	%
<40	2	6.7
40-50	5	16.7
51-60	9	30.0
61-70	10	33.3
71-80	4	13.3
Total	30	100.0

Table 2: showing age distribution of patients studied

36.7% of patients had diabetes of 11-20 years range. Around 33.3% had diabetes of less than 10 years and 30% had diabetes of more than 20 years duration (Figure 3).

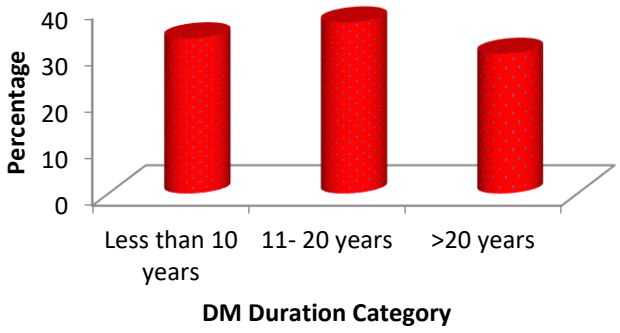

Figure 3: showing diabetes mellitus duration distribution of patients studied

Right foot (46.7%) was commonly affected with 13.3% having bilateral feet involvement (Figure 4).

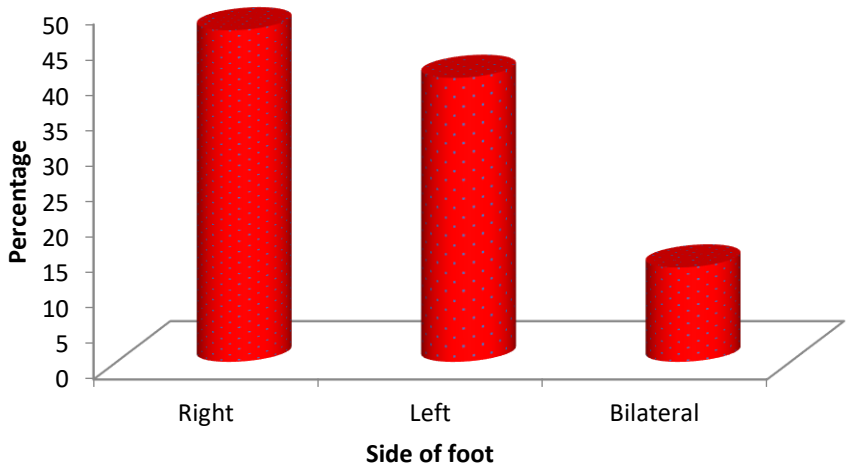

Figure 4: showing distribution of side of foot affected.

56.7% had hypertension. All patients (100%) had peripheral neuropathy and 1 patient had underlying peripheral arterial disease with ABI of 0.73. All the calluses (100%) occurred in forefoot region. Metatarsophalageal joints were most commonly affected region (50%) followed by Great toe affecting 47.7% [Table 3]. 26.7% of the patient had 1st MTP involved.

Site of callus	No. of patients	%
1st MTP region	8	26.7
2nd toe (Lesser toe)	1	3.3
5th MTP region	4	13.3
Central MTP region	2	6.7
Great toe	14	46.7
Both 1st & 5th MTP region	1	3.3
Total	30	100.0

Table 3: showing site of callus distribution of patients studied.

93.3% of patients had single callus and 6.7% had multiple callus. 53.3% had callus less than 2 cm, 40% had between 2-4cm and 6.7% had more than 4 cm in size. 53.3% had type 1 callus (Figure 5 & 5a), 40% had type 2 (Figure 6) and 6.7% had type 3 callus [Table 4]. 6.7% of patients with diabetic foot callus received oral antibiotics.

Type of callosities	No. of patients	%
Type 1 callus (Simple)	16	53.3
Type 2 callus (Complex)	12	40.0
Type 3 callus (Complicated)	2	6.7
Total	30	100.0

Table 4: showing distribution of callosities according to Amit Jain's classification.

Figure 5: showing callus over right foot. This is type 1 callus as per Amit Jain's classification.	**Figure 5a:** of the above patient after debridement. There is no ulcer underneath after debridement. This is type 1 callus.
	

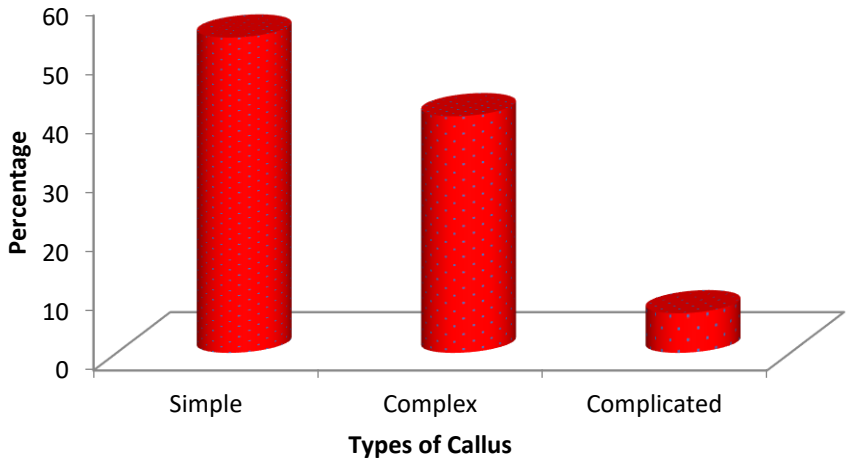

Figure 6: showing distribution of types of callus according to Amit Jain's classification.

There was no association of gender, diabetes mellitus duration, side of foot involved, region of foot, site of foot , size of callus and peripheral neuropathy with type of callus although association was seen with age, antibiotics usage and number of calluses [Table 5]. Majority of the patients with type 3 callus (complicated callus) where less than 40 years of age whereas type 1 callus (simple callus) wasn't seen that age (Figure 7). Further, type 2 and type 3 callus were common in age group of 61-70 years wherein type 1 callus was less frequently seen (P-0.061+, significant). 100% of type 1 callus and 91.7% of type 2 callus were single in number whereas type 3 callus had 50% of them being single and multiple in numbers each (Figure 8). Further all type 3 callus received oral antibiotics (P-0.002**, significant).

Variables	Types of Callus			Total (n=30)	P value
	Type 1 callus (Simple) (n=16)	Type 2 callus (Complex) (n=12)	Type 3 callus (Complicated) (n=2)		
Age in years					
<40	0(0%)	1(8.3%)	1(50%)	2(6.7%)	**0.061+**
40-50	5(31.3%)	0(0%)	0(0%)	5(16.7%)	
51-60	6(37.5%)	3(25%)	0(0%)	9(30%)	
61-70	3(18.8%)	6(50%)	1(50%)	10(33.3%)	
71-80	2(12.5%)	2(16.7%)	0(0%)	4(13.3%)	
Gender					
Male	10(62.5%)	6(50%)	2(100%)	18(60%)	0.524
Female	6(37.5%)	6(50%)	0(0%)	12(40%)	
Diabetes mellitus duration					
Less than 10 years	5(31.3%)	4(33.3%)	1(50%)	10(33.3%)	0.214
11- 20 years	8(50%)	2(16.7%)	1(50%)	11(36.7%)	
>20 years	3(18.8%)	6(50%)	0(0%)	9(30%)	
Side of Foot					
Right	7(43.8%)	7(58.3%)	0(0%)	14(46.7%)	0.485
Left	7(43.8%)	4(33.3%)	1(50%)	12(40%)	
Bilateral	2(12.5%)	1(8.3%)	1(50%)	4(13.3%)	
Region of foot					
Forefoot	15(93.8%)	12(100%)	2(100%)	29(96.7%)	1.000
Midfoot	0(0%)	0(0%)	0(0%)	0(0%)	
Hindfoot	1(6.3%)	0(0%)	0(0%)	1(3.3%)	
Number of callus					
Single	16(100%)	11(91.7%)	1(50%)	28(93.3%)	**0.057+**
Multiple	0(0%)	1(8.3%)	1(50%)	2(6.7%)	
Site of callus					
Great toe	8(50%)	5(41.7%)	1(50%)	14(46.7%)	0.446
1st MTP region	5(31.3%)	3(25%)	0(0%)	8(26.7%)	
5th MTP region	1(6.3%)	3(25%)	0(0%)	4(13.3%)	

Central MTP	1(6.3%)	0(0%)	1(50%)	2(6.7%)	
2nd toe	1(6.3%)	0(0%)	0(0%)	1(3.3%)	
1st & 5th MTP region	0(0%)	1(8.3%)	0(0%)	1(3.3%)	
Size of Category					
Less than 2 cm	9(56.3%)	7(58.3%)	0(0%)	16(53.3%)	0.416
2-4 cm	5(31.3%)	5(41.7%)	2(100%)	12(40%)	
More than 4 cm	2(12.5%)	0(0%)	0(0%)	2(6.7%)	
Peripheral neuropathy					
Yes	16(100%)	12(100%)	2(100%)	30(100%)	1.000
No	0(0%)	0(0%)	0(0%)	0(0%)	
Antibiotics					
Yes	0(0%)	0(0%)	2(100%)	2(6.7%)	**0.002****
No	16(100%)	12(100%)	0(0%)	28(93.3%)	

Table 5: showing clinical variables distribution in relation to types of callus of patients studied

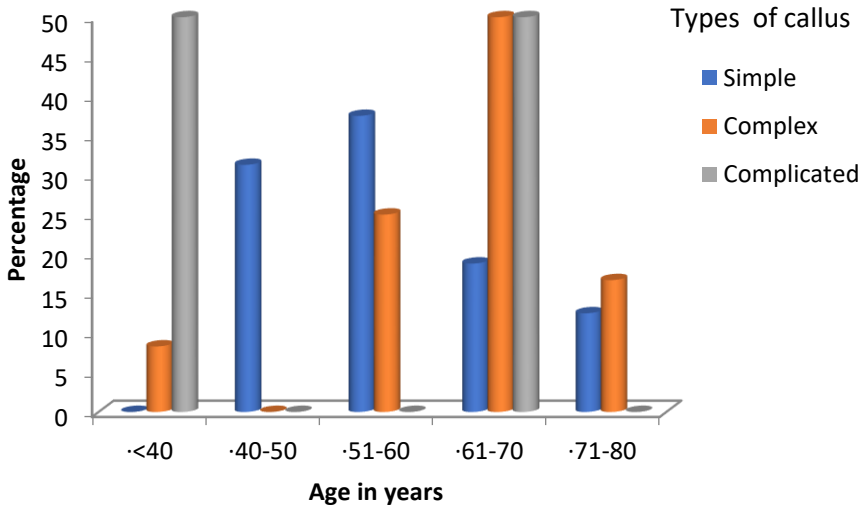

Figure 7: showing distribution of type of callus with age.

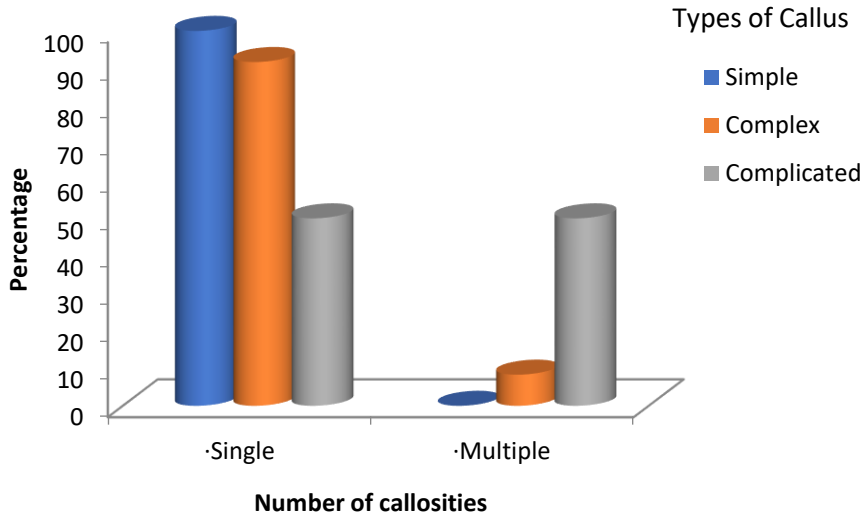

Figure 8: showing distribution of number of callosities with Amit Jain's types of calluses.

There was no association of region of foot, size of callus and number of callus although association was seen with site of callus with age [Table 6]. Patients with less than 50 years had callus commonly at great toe whereas callus at MTP joint region common above 50 years of age.

Variables	Age in years			Total (n=30)	P value
	Up to 50yrs (n=7)	51-70yrs (n=19)	More than 70yrs (n=4)		
Region of foot					
Forefoot	6(85.7%)	19(100%)	4(100%)	29(96.7%)	0.367
Midfoot	0(0%)	0(0%)	0(0%)	0(0%)	
Hindfoot	1(14.3%)	0(0%)	0(0%)	1(3.3%)	
Site of callus					
Great toe	6(85.7%)	7(36.8%)	1(25%)	14(46.7%)	**0.026***
Lesser toes	0(0%)	0(0%)	1(25%)	1(3.3%)	
MTP regions	1(14.3%)	12(63.2%)	2(50%)	15(50%)	
Size of callus					
Less than 2 cm	4(57.1%)	10(52.6%)	2(50%)	16(53.3%)	0.903
2-4 cm	2(28.6%)	8(42.1%)	2(50%)	12(40%)	
More than 4 cm	1(14.3%)	1(5.3%)	0(0%)	2(6.7%)	
Number of callus					
Single	6(85.7%)	18(94.7%)	4(100%)	28(93.3%)	0.607
Multiple	1(14.3%)	1(5.3%)	0(0%)	2(6.7%)	

Table 6: showing comparison of study variables (frequency distribution) in relation to age of patients studied

There was no association between regions of foot, site of callus, size of callus with side of foot [Table 7] although significant association was seen between number of calluses and side of foot wherein single callus was 100% present equally on left and right side whereas multiple callus were common bilaterally (P-0.014*, significant)

Variables	Side of Foot			Total (n=30)	P value
	Right (n=14)	Left (n=12)	Bilateral (n=4)		
Regions of foot					
Forefoot	14(100%)	12(100%)	4(100%)	30(100%)	1.000
Midfoot	0(0%)	0(0%)	0(0%)	0(0%)	
Hindfoot	0(0%)	0(0%)	0(0%)	0(0%)	
Site of callus					
Great toe	8(57.1%)	4(33.3%)	2(50%)	14(46.7%)	0.629
Lesser toes	0(0%)	1(8.3%)	0(0%)	1(3.3%)	
MTP regions	6(42.9%)	7(58.3%)	2(50%)	15(50%)	
Size of callus					
Less than 2 cm	9(64.3%)	6(50%)	1(25%)	16(53.3%)	0.604
2-4 cm	4(28.6%)	5(41.7%)	3(75%)	12(40%)	
More than 4 cm	1(7.1%)	1(8.3%)	0(0%)	2(6.7%)	
Number of callus					
Single	14(100%)	12(100%)	2(50%)	28(93.3%)	**0.014***
Multiple	0(0%)	0(0%)	2(50%)	2(6.7%)	

Table 7: showing study variables (frequency distribution) in relation to side of foot of patients studied

No association was seen between duration of diabetes with type of callus [Table 8].

DM Duration of Category	Type of callus			Total	P value
	Type 1 callus (Simple)	Type 2 callus (Complex)	Type 3 callus (Complicated)		
Less than 10 years	5(31.3%)	4(33.3%)	1(50%)	10(33.3%)	0.214
11- 20 years	8(50%)	2(16.7%)	1(50%)	11(36.7%)	
>20 years	3(18.8%)	6(50%)	0(0%)	9(30%)	
Total	16(100%)	12(100%)	2(100%)	30(100%)	

Table 8: showing diabetes mellitus duration distribution in relation to Amit Jain's types of callus.

DISCUSSION

Although the definition of callus is not clear (Amemiya, A., *et al*. 2016), it is considered to be a "broad based diffuse hyperkeratotic lesion of relatively even thickness that spread across ball of foot or along the outer edge of heel" (Grouios, G. 2004). Amemiya *et al* in their study defines callus "as a plate shaped hyperkeratosis" (Amemiya, A., *et al*. 2016).

Calluses are common problems that affect foot especially of elderly and studies shows it to affect 33-68% of people over 65 year's age (Spink, M. J., *et al*. 2009; Cirakli, A., *et al*. 2016). Calluses are considered as natural defense mechanism/reaction to extreme mechanical

stress/prolonged pressure on skin resulting in increase skin thickness (Cirakli, A., *et al*. 2016; Nogueron, G. G., *et al*. 2015). This is often considered to be physiological by many and it is rendered pathological when it causes pain or ulcer (Jain, A. K. C., & Sabasse, M. 2015; Nogueron, G. G., *et al*. 2015). Callus is also known as tyloma or clavus (Grouios, G. 2004).

Callus in diabetic foot is common (Colagiuri, S., *et al*. 1995) and should always be considered pathological as it causes abnormal elevated foot pressures (Jain, A. K. C., & Sabasse, M. 2015). A callus is believed to cause 18,600kg of excess plantar pressure per day (Pataky, Z., *et al*. 2002) and is thus a precursor of ulcer and subsequent amputation (Jain, A. K. C. 2019. The relative risk of ulcer formation under a callus is 11 times greater compared to other region of foot (Jain, A. K. C., & Sabasse, M. 2015; Murray, H. J., *et al*. 1996). In fact, callus formation precedes ulcer formation in over 82% of the diabetic foot ulcer patients (Amemiya, A., *et al*. 2016).

Callus is formed through increased cell adhesion, reduced shedding and thickening of epidermal layer of skin (Grouis, G. 2004). In diabetic foot, there are various intrinsic factors like claw toes, flat foot, hammer toe, etc which results in abnormal gait leading to callus formation (Grouis, G. 2004). Extrinsic factors like walking bare foot, improperly or poorly fitting footwear's can also lead to callus (Grouis, G. 2004).
Studies have shown callus to be common in females in general (Cirakli, A., *et al*. 2016). In our study done on diabetics, we found males to be more commonly affected by callus. Callus is also common in older people usually above 65 years (Spink, M. J., *et al*. 2009; Cirakli, A., *et al*. 2016). In our study, majority of callus was in patients above 60 years of age. Type 2 (Figure 9 & 9a) and type 3 callus were significantly common in age group of 61-70 years. A study on old people showed callus to be common under 1st metatarsophalangeal joint (MTPJ) followed by 2nd MTPJ and the hallux (Spink, M. J., *et al*. 2009). In our study in diabetics, metatarsophalangeal joints were the commonest site for callus with first MTP joint being commonest.

Treatment of callus consists of mechanical debridement (Nogueron, G. G., 2015). Pataky *et al* showed that callus removal decreases peak plantar pressure by 58% (Judge, M. 2014). Conservative management of callus consists of padding, use of therapeutic footwear (Grouis, G. 2004). Callus can recur in as high as 41% of the cases (Amemiya, A., *et al*. 2016).

Figure 9: showing callus over right foot in 1st MTP joint region. It is type 2 callus as per Amit Jain's classification as there was ulcer underneath (see figure below).

Figure 9a : of Below patient. Note the underlying ulcer after debridement. This is type 2 callus

CONCLUSION

Callus in diabetic foot are common. Just like other studies, callus in our study were common in old aged people especially the type 2 and type 3 callus. Unlike other studies, males were found to be commonly affected. Majority of type1 and type 2 callus were single in number. Antibiotics were used only in type 3 callus in view of underlying infection. Amit Jain's classification for callus which is an extended 'SCC" classification is a new, simple, easy, practical classification that categorizes callus into 3 types and it guides in treatment.

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Conflict of interest – None
Ethical clearance- This study was approved by ethics committee (RRMCH-IEC-173/2019-20).

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