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Review Article

Amit Jain's system of practice for diabetic foot: the modern diabetic foot surgery

Gopal S., Haridarshan S. J.*

Department of Surgery, Rajarajeswari Medical College, Bangalore, Karnataka, India

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***Correspondence:**
Dr. Haridarshan S. J.,
E-mail: sjharidarshan@gmail.com

ABSTRACT

Diabetic foot is a complex disease and one of the most common complications of diabetes mellitus. It is also a dreaded complication in view of the fact that patient may end up in an amputation rendering him dependant. Diabetic foot was well known to be neglected by patients and health care professional. Even our understanding of this disease was limited especially in underdeveloped and developing country. Amit Jain's system of practice for diabetic foot, a modern diabetic foot surgical approach, is a new system for diabetic foot that has various new innovative concepts in diabetic foot. Majority of these concepts are unique and they have improvised our approach towards diabetic foot. This article currently highlights few of the concepts of this modern diabetic foot surgery system that has revolutionized the practice of diabetic foot.

Keywords: Diabetes, Foot, Amit Jain, India, Classification, System, Modern, Amputation, Scoring, Mortality

INTRODUCTION

Diabetic foot, a serious and devastating complication of diabetes mellitus, is a leading cause of hospitalization due to diabetes.[1,2] It is estimated that around 15% of all diabetics who are hospitalized are due to foot complications.[3] Foot problems in diabetes are associated with increased morbidity and mortality and there is risk of amputation which is 15 times greater than non diabetic population.[3,4]

In spite of knowing the above facts, diabetic foot is neglected both by patient and also by the treating healthcare professionals. Further, in developing country like India, there are various factors that increase the risk of foot problems like walking barefoot, religious practices like walking on the fire, poor knowledge of diabetes and its complication, socioeconomic factors, etc.[4]

There is well known differences in diabetic foot problems among Asian and western population.[5,6] Further, the education system of treating doctors and their skills are distinct from western counterparts.[7] There is also well known difference in disease occurrence, delayed presentation, etc.

In spite of knowing all these differences, various concepts in diabetic foot were followed from western literature.[8]

In order to improvise and standardize the practice of diabetic foot across the world, a new principle and practice of diabetic foot was laid by Amit Jain, a renowned pioneering surgeon from India.[8,9,10] This distinct system lay down by Amit Jain, who has fathered the concept of modern diabetic foot surgery, consists of various new concepts that have changed the perception as well as the management of diabetic foot.[6,8,11]

This article aims to discuss some of the innovative modern concepts from Amit Jain's system of practice for diabetic foot.

AMIT JAIN'S CLASSIFICATION FOR DIABETIC FOOT CLASSIFICATION – CLEARING THE CONTROVERSIES

The authors have observed that often people have mixed up classifications in diabetic foot and their expectations from different classifications are varied and many are assessed for the function and properties which the classification is not meant for. This leads to huge confusion among readers who will misunderstand a classification and its purpose. Example like expecting a diabetic foot classification to give follow-up action or patient survival or reamputation or specific treatment for each lesion in it, etc. Many of such expectations by researchers are undesirable properties especially in diabetic foot where there are multiple pathological lesions with varied presentation and complexity of this disease is well known.

The 3 biggest development that has taken place in diabetic foot classification system in the recent years is development of classifications for the diabetic foot classifications itself, development of a universal classification for diabetic foot that has eased our understanding of diabetic foot classifications system and also development of first surgical scoring system for diabetic foot complications by Amit Jain. These have laid rest to various controversies around diabetic foot classifications and their global acceptance.[6,12]

There is no doubt that for decades there has always been a controversy in regards to which is the best classification for diabetic foot and most often one can observe that these controversies are often created by researchers themselves. A classification which is considered good by one is not considered good by another researcher. One researcher feels that predictive classifications are better than descriptive classification for diabetic foot ulcers whereas another researcher feels that there is a difference between a classification and a scoring and researchers often mixed this up leading to confusion regarding classification system for diabetic foot.[13,14]

Further, researchers have done unequal comparisons among classification and expecting non desirable properties from classification like follow-up action has further added to the problems thereby confusing healthcare professionals on diabetic foot classification.[15] The authors have observed that many of the researchers themselves aren't clear what has to be expected from a classification and one cannot completely fulfill their all expectation. Rather looking at what the community needs and how it can be benefitted from understanding diabetic foot, un necessary confusion have been added especially by mixing different classifications and scoring and also having different expectations for different classifications which the classification is not meant for. Another irony is that, all those who would frequently find faults in all the existing classifications, themselves have failed to give a better classification that would fulfill their own expectations.

Amit Jain's new classifications for diabetic foot classification is a novel and most excellent effort in recent years that clear the above controversies created by many researchers worldwide and make one understand diabetic foot classifications that have been laid by different authors over decades in a very simplified, easier, clearer and in a comprehensive manner.[12]

This pattern clearly differentiated the original classifications versus the derivative classification, the simple classification versus the complex classification, universal classification versus an ideal classification, historic classification versus modern classification, etc.[12] The most important part of this new effort was creation of a clear distinction between a complete, incomplete and focal classification for diabetic foot that would clear the 'literature confusion' on diabetic foot, a term coined by Amit Jain.[16] Almost majority of the researchers have wrongly assumed that diabetic foot is "Diabetic Foot Ulcer" only and that's why controversies on classification existed till date.[13-15] Amazingly various reviewers who opined on various classifications and their merits and demerits could never looked beyond ulcers.

With a clear clarity of not mixing classification with scoring, distinction between descriptive classification and predictive classification and based on this new classification systems for diabetic foot classification system, it is now obvious that the new Amit Jain's classification for diabetic foot complication is the only complete diabetic foot classification system that is now a universal classification for diabetic foot on whole and those who looks at scoring system for prediction could look so through a separate Amit Jain's scoring system thereby laying rest to all the confusion that was created on different aspects of diabetic foot.[6, 17]

AMIT JAIN'S CLASSIFICATION FOR DIABETIC FOOT COMPLICATION – THE NEW UNIVERSAL CLASSIFICATION FOR DIABETIC FOOT

The biggest development was developing a universal classification for diabetic foot as a whole entity. The Amit Jain's classification for diabetic foot complications was first proposed in 2012 from Indian subcontinent that changed the perception of diabetic foot.[6,17-19] For decades, diabetic foot was studied only through ulcers and this classification made us look beyond ulcers and included almost all common lesions seen in diabetic foot worldwide thereby making it to be a universal classification supreme.[6,12]

This classification, which is the simplest classification on diabetic foot till date in the world, divides diabetic foot

into 3 simple types namely type 1 diabetic foot complications, type 2 diabetic foot complications and type 3 diabetic foot complications (Table 1).[17-20]

All infective lesions can be placed in type 1 diabetic foot complications, all the non infective lesions can be placed in type 2 diabetic foot complications and once a type 2 diabetic foot complications get infected, it can be placed in type 3 diabetic foot complications.[17-20] This classification smoothly addresses the triopathy namely the neuropathy (neuropathic ulcer, hammer toe, claw toe, charcot foot, etc), infection (abscess, cellulitis, necrotizing fasciitis, etc) (Figure 1 and 2) and vasculopathy (ischemic ulcer, dry gangrene). This simple descriptive classification with multi-lesions in it is practical, easy to understand by every healthcare professional, reproducible and is applicable in day to day practice.[6,17]

Table 1: Amit Jain's universal classification of diabetic foot complications.

Sl no	Types of diabetic foot complication	Lesions	General guidelines
1	Type 1 diabetic foot complication [infective]	Wet gangrene, Cellulitis, Abscess, Necrotizing fasciitis, Gas gangrene, Tinea pedis, etc.	Needs antimicrobials, urgent surgical debridement/ amputation in view of acuteness of some conditions Standard wound care.
2	Type 2 diabetic foot complication [non infective]	Trophic/ neuropathic ulcer, Hammer toe, Claw toes, Ischemic ulcer, Charcot foot, Dry gangrene, etc.	No antibiotics, requires detailed workup like duplex, angiograms, CT scan, etc. Correction of underlying intrinsic cause like bony correction, revascularization, etc. Standard wound care and offloading based on lesions
3	Type 3 diabetic foot complication [mixed]	Best example – non healing ulcer with osteomyelitis	Needs antimicrobial's, surgical intervention and correction of intrinsic cause. Also standard wound care and offloading

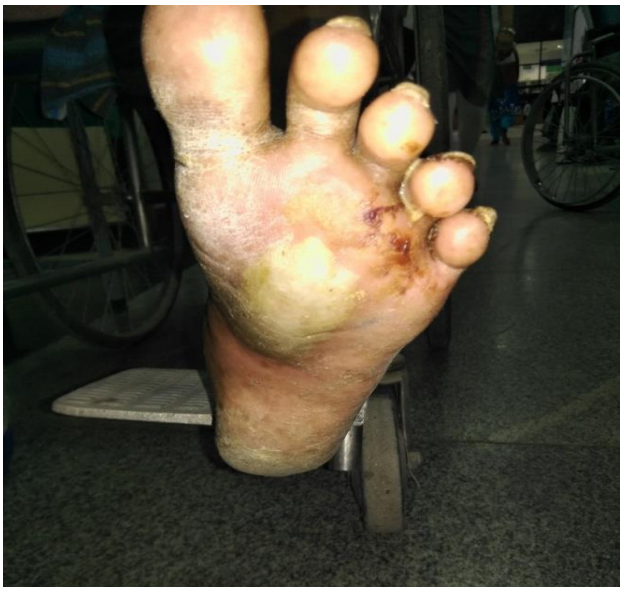

Figure 1: Plantar abscess left foot; this is Amit Jain's type 1 diabetic foot complication.

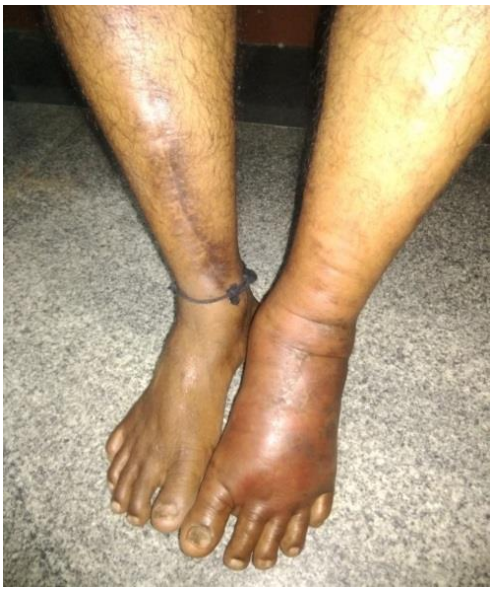

Figure 2: Primary cellulitis of the left foot; this is Amit Jain's type 1 diabetic foot complication; this is also stage 1 cellulitis according to Amit Jain's staging system.

Numerous studies done on the Amit Jain's classification for diabetic foot complications showed that type 1 diabetic foot complications are the most common cause of hospitalization in tertiary care hospital ranging from 60% to 91% in different series.[17,21-23]

Recent studies have shown that the major amputation most commonly occurred in type 1 diabetic foot complications.[24, 25] In Kalaivani et al series, it is seen that

85.7% of all major amputation occurs in type 1 diabetic foot complication.[25] There is however geographic difference in diabetic foot and it's well known that different regions may have different lesions to be more common in that zone.

In a study by Jain et al on stump complications, it was observed that 78.57% with stump complications were operated for type 1 diabetic foot complications.[26] In a study on transmetatarsal amputation in diabetic foot, it was seen that around 76% of patients with transmetatarsal amputation had type 1 diabetic foot complication.[27] It was also seen that majority of patients (78.38%) with in hospital mortality in diabetic foot occurred in patients with type 1 diabetic foot complications.[28]

Based on the new classification for diabetic foot classifications, it is now clear that Amit Jain's classification for diabetic foot complications is a simple, easy, practical, original, complete classification that includes all the common lesions seen universally and addresses the triopathy of diabetic foot efficiently.[6,12]

Further, there should be a difference in an ideal classification and a classification that can be universal and both should not be mixed in diabetic foot.[12]

Often reviewers expect a classification to guide treatment and predict outcome of it. The authors feel that the new Amit Jain's universal classification should not be fitted in these expectations due to multiple reasons. First of all, this is the only complete classification for diabetic foot till date. So obviously comparing it with focal classifications that addresses like ulcers only would be a big error as focal classifications include a single entity and such classification would be able to guide therapy for that lesion and also would predict specific outcome from that classification. Amit Jain's classification for diabetic foot complications is a general descriptive classification that has dozen of lesions in it with varied spectrum of presentation and with varied severity. Further each lesions within this classification like cellulitis, osteomyelitis, necrotizing fasciitis etc itself have their separate focal classification that guides treatment and predict individual outcomes. Expecting Amit Jain's classification on whole to guide treatment for each of these lesions and predict outcome is nothing but an error by researchers/ reviewers. This classification gives an overall guideline on treatment and also gives anb overall outcome prediction like majority of major amputation occurs in type 1 diabetic foot complications, mortality is more in type 1 diabetic foot complications, etc.[8]

Secondly, Amit Jain's classification has a supportive scoring system which distinctly predicts the outcome thereby keeping this classification purely for descriptive purpose and scoring for prediction and it avoided mixing of both. Thirdly, few of the lesion in this universal classification has separate focal classification like Amit Jain's staging for cellulitis, Amit Jain's ulcer classification, Amit Jain's osteomyelitis classification etc that are known to guide therapy and predict outcomes individually.[8]

Some lesions like Charcot foot also have independent focal classification by different authors that are good to guide therapy and predict outcomes.

Lastly and importantly, Amit Jain's new universal classification is governed by law of classification. This law of classification clearly describes the complexity of diabetic foot and henceforth this law shall stop the researchers/ reviewers from creating further controversies.[6, 8] To understand this classification and the law, the authors feel that one needs to completely be familiar with Amit Jain's principle and practice of diabetic foot before making any judgments as this system has many sequel's that were laid over years forming a new modern diabetic foot system.[8]

The authors feel that development of a universal classification of descriptive nature by including those lesions that weren't looked upon for decades by most researchers and also developing a distinct universal surgical scoring system that uniquely included those essential necessary surgical, clinical, anatomical and pathological entities are one of the best contribution by Amit Jain and it clears the controversies in diabetic foot and makes our understanding much clearer.[17,29]

A word of cautious is that one should not mix Amit Jain's classification for diabetic foot complications and Amit Jain's classification for diabetic foot ulcers as both are different.[8]

AMIT JAIN'S SCORING SYSTEM – THE FIRST SURGICAL SCORING SYSTEM FOR DIABETIC FOOT COMPLICATIONS

This is the first surgical scoring system for diabetic foot complications in 2013 by Amit Jain.[29] This scoring system uniquely includes clinical, radiological, anatomical and intraoperative findings to predict the risk of major amputation (Table 2).[24,29] Astonishingly, previous amputation and myonecrosis have significant impact on outcome and further amputations and no scoring looked into it earlier.

This scoring has 16 essential parameters in it. Further the scores are given to region of foot affected which is unique feature as its well known that different parts of foot may have different surgical outcome.[24,29] Inclusion of myonecrosis, presence of gas, septic shock, surgeon specialty, etc are some of the unique features in this scoring system for the first time which as surgeons we agree to be essential in outcomes which was not looked upon by other scoring system over decades.

The advantage of this scoring system is its simplicity, practicality and inclusion of majority of the common complications of the diabetic foot disease which no scoring system did earlier. This scoring system is useful teaching tool, can be used for research purpose and to audit.[29]

In a study analyzing transmetatarsal amputation in diabetic foot, it was observed majority of patients who underwent transmetatarsal amputation belonged to moderate risk and low risk group. All the transmetarsal amputation patients who had high risk score (score 16-20) ended up in major amputation.[27]

Table 2: The Amit Jain's surgical scoring system for diabetic foot.

Sl no	Characteristics Features/ lesions	involvement of foot			
1	Presence of ulcer	No ulcer → 0	Forefoot ulcer → 2	Midfoot ulcer → 4	Hindfoot ulcer/ full foot/beyound → 6
2	Osteomyelitis [O.M]	No O.M→ 0	Forefoot O.M → 2	Midfoot O.M→ 4	Hindfoot O.M→ 6
3	Presence of pus	No PUS→ 0	Forefoot pus/dorsum→ 2	Midfoot pus→ 4	Hindfoot pus/beyond it → 6
4	Gangrene [dry/wet]	No gangrene→0	Forefoot gangrene → 2	Midfoot gangrene →4	Hindfoot gangrene/beyond→8
5	Peripheral arterial disease	No P.A.D→ 0	MILD→ 2	Moderate→ 4	Severe→ 8
6	Charcot foot/ destroyed joints	No→ 0	Forefoot → 2	Midfoot → 4	Hindfoot/whole foot → 8
7	Necrosis [skin]	No→ 0	Forefoot necrosis →2	Midfoot necrosis →4	Hindfoot necrosis/beyond→8
8	Associated cellulitis	No→ 0	Upto forefoot→2	Upto midfoot→4	Upto hindfoot & beyond→ 6
9	Previous amputation	No → 0	Toe amputation → 2	Forefoot amputation → 4	Midfoot amputation→ 6
10	Presence of gas – radiologically	No → 0	Gas in forefoot→ 1	Gas in/upto midfoot→ 2	Gas in/upto hindfoot→ 3
11	Myonecrosis	No → 0	Myonecrosis involving single muscle group→ 2	Myonecrosis involving more than one group → 4	Myonecrosis of entire foot muscle with extension to leg → 8
12	Joint involvement	No → 0	Forefoot joint exposure→ 2	Midfoot joint exposure→ 4	Hindfoot joint exposure → 6
13	Septic shock	No → 0		Present → 2	
14	Renal failure [acute]	No → 0		Present → 2	
15	Smoking [heavy smoker]	No → 0		Present → 2	
16	Surgeon factor	Podiatric/diabetic foot surgeon → 0		Other surgeons → 2	

In a study of major amputation through this scoring system, it was seen that 34.62% of the patients had score between 16 to 20 thereby belonging to category of high risk of major amputation. 26.92% of these patients had score between 21-25.[24]

In Kalaivani et al series, it was observed that around 85.7% of patients with major amputation had a score above 16 and most of them had wet gangrene followed by foot abscess.[25]

In another study dealing with stump complications in major amputation, it was observed that majority of patients (35.71%) with stump complications belonged to high risk category whereas 14.28% of them with stump complications had score between 21-25.[26]

In a recent study by Jain et al, It was observed that with increasing scores for diabetic foot, there was statistically significant increase in the major amputation.[17] All the 3 patients in this study who had score of more than 25 belonging to inevitable amputation category ended up in major amputation. It was also one should be treating most of the lesions in diabetic foot to properly evaluate and understand this scoring otherwise it's possible to have an error in understanding this scoring system.[28]

One limitation of this scoring system is that it is difficult to memorize especially by non foot specialist.[29]

AMIT JAIN'S GRADING FOR DEBRIDEMENT FOR DIABETIC FOOT

Debridement is one of the most common surgical procedures performed for diabetic foot complications.[21, 30] In a recent series of Jain et al, debridement accounted for 47.5% of all surgical procedure done on diabetic foot.[17] In Kalaivani et al series, debridement was most common surgical procedure and accounted for 53.66% of all surgeries done on diabetic foot.[22] In spite of it being such a common procedure for diabetic foot, there was no classification system for debridement for decades.[10,30,31]

Amit Jain for the first time laid down a new grading system for debridement in diabetic lower limb.[31] It later had small modification.[30] This classification for debridement (Table 3) has 3 components namely grade, extent and repetition.[30-32]

Table 3: Amit Jain's modified grading for debridement.

Grade of debridement [G]	Description	Modified coding
Grade 1	Removal of sloughs from the ulcer, callus removal, deroofing the large blisters/blebs, removal of dessicated tendons,etc	G 1
Grade 2	Removal of necrotic/unhealthy skin and subcutaneous tissue	G 2
Grade 3	Removal of infected/necrotic skin, subcutaneous tissue along with either tendons/retinaculum/deep fascia	G 3
Grade 4	Removal of infected/necrotic skin,subcutaneous tissue, tendon/retinaculum/deep fascia along with necrotic/ infected muscle	G 4
Extent of debridement [e]		
Only 1 site [foot/ leg/ thigh]		E 1
2 sites [foot+ leg or leg+ thigh]		E 2
3 sites [foot+leg+thigh]		E 3
Repetition of debridement [r]		
Debridement not repeated		R 0
Debridement repeated once		R 1
Debridement repeated twice		R 2
Debridement repeated thrice		R 3
Debridement repeated …..		R….

The grade refers to depth of tissue removed, the extent involves foot, leg or thigh and repetition refers to number of times the debridement done in operation theatre.

Jain et al in his series showed that grade 2 debridement is the most common type of debridement done in 56.36% followed by grade 3 debridement that accounts for 32.73%. Around 72.72% of the cases in Jain et al series had debridement at one site only and in 67.27% of cases it was debrided only once.[33]

This debridement can be used like oncological TNM staging.[30]

This classification for debridement is easy, simple, practical, reproducible, can be applied in day to day clinical practice, can be used as a common communication tool universally and is an excellent teaching tool.[31] It can be used in non diabetics and in upper limbs too. This debridement classification can also define the debridement type that can be performed by paramedics.[31]

AMIT JAIN'S STAGING SYSTEM FOR CELLULITIS IN DIABETIC LOWER LIMB

This staging system for cellulitis for diabetic lower limb was first proposed by Amit Jain in 2014.[16] This is first such exclusive clinical staging for cellulitis and its local complication for lower limb.[16,34,35]

This staging system for primary cellulitis in diabetic lower limb (Table 4) has 4 sequential progressive stages.[8,16]

Studies from Jain et al showed that Stage 2 cellulitis for diabetic lower limb is the most common in hospitalized patient accounting for 42.31% of all cases of cellulitis in diabetic lower limb followed by stage 1 cellulitis (Figure 2).[35] Stage 4 is the most dangerous stage where in there is necrotizing fasciitis with myonecrosis and it is uncommon and accounts for 3.85% of all cases of cellulitis.[35]

In a another recent validation study on this staging system, it was found that stage 2 was common accounting for 41% of the cases of cellulitis.[34] It was seen in this

study that patients with higher stages of cellulitis are more likely to undergo surgical intervention, have multiple surgeries and amputations and they were statistically significant.[34]

Table 4: Amit Jain's staging system for cellulitis.

Stage of cellulitis	Clinical description	Treatment guideline
Stage 1	Cellulitis without any abscess or necrosis	Broad spectrum antibiotics, limb elevation, and crepe bandage. Monitor the patient daily
Stage 2	Cellulitis with either localized abscess or skin necrosis	Requires some form of surgical intervention, like drainage of abscess or debridement.
Stage 3	Necrotizing fasciitis without myonecrosis	Extensive radical debridement of all the devitalized tissues/ amputation based on extensiveness
Stage 4	Necrotizing fasciitis with myonecrosis	Radical debridement and some form of amputation is invariably performed at this stage

This staging system for diabetic lower limb is first such ever simple, practical, easy to remember staging system which is also applicable to day to day clinical practice.[16] It also an excellent teaching tool and can form a common communication tool worldwide. This staging system helps predicting limb salvage and also can be used in non diabetics and also in upper limbs.[16]

CONCLUSION

Diabetic foot is undoubtedly a complex disease and for years remained an enigma for professionals. The Amit Jain's principle and practice of diabetic foot is the new modern diabetic foot surgical approach that has changed our perception towards diabetic foot. This new system aimed at improvising and standardizing diabetic foot across the world. We commensurate the efforts done by Amit Jain and et al towards developing a new system of practice that ease our understanding of diabetic foot and that helps us in management of different aspects of it.

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