Original Research Article

DOI: http://dx.doi.org/10.18203/2349-2902.isj20175110

Analysis of cellulitis in diabetic lower limb along with its local complications using Amit Jain's staging system: a cross sectional descriptive study

Gopal S., Santosh M. P.*

Department of General Surgery, Raja Rajeswari Medical College and Hospital, Bangalore, Karnataka, India

Received: 24 October 2017 Accepted: 04 November 2017

*Correspondence: Dr. Santosh M. P.,

E-mail: dr.santoshmp@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Cellulitis is a common surgical emergency seen in clinical practice. Inspite of it being frequently seen, most of the times it is under rated and under treated. The study aims to analyze cellulitis in diabetic lower limbs and its local complications using Amit Jain's staging system. It also sought to predict the outcomes associated with cellulitis and surgical procedures done in them.

Methods: The study is a cross sectional descriptive analysis in the Department of General Surgery at RajaRajeswari Medical College & Hospital between April 2016 to March 2017.

Results: Around 92.3% of the patients were above 40 years of age. Majority of our patients (74%) had diabetes mellitus of less than 10 years duration. 21 patients (53.8%) in the study had associated co morbid conditions, with hypertension being the most common. Most of the patients had stage 2 cellulitis (41%), followed by stage 1 (33%) and stage 4 (20.5%). Almost 80% of the patients underwent some form of surgery as the initial treatment. With increasing stage of cellulitis, the need for surgery, re-operations and risk of major amputations increases and this was found to be statistically significant.

Conclusions: This study validates the Amit Jain's staging system for diabetic lower limb and it predicts the need for surgeries, reoperations and risk of amputation.

Keywords: Amit Jain, Amputation, Cellulitis, Diabetic foot

INTRODUCTION

The number of people with diabetes worldwide was 131 million in 2000 and it is likely to increase to 366 million by 2030. Infective complications of the diabetic lower limbs are also on the rise and it is estimated that about 15% of people with diabetes will develop foot ulcers during their lifetime. ²

Even when diabetic foot infections (DFIs) are acute and relatively mild, they usually cause major morbidity, including physical and emotional distress and loss of mobility, as well as substantial direct and indirect

financial costs. If the infection progresses, many patients require hospitalization and, all too often, surgical resections or an amputation. Infective diabetic foot complications continue to be the main reason for diabetes-related hospitalization and lower extremity amputations.³

Although skin and soft tissue infections (SSTIs) are extremely common, there is a lack of validated evidence-based schemes for the classification of clinical presentation or severity, and there are few data available on treatment outcomes.⁴ Most of the currently used classifications concentrated on diabetic foot ulcer and its

sequelae, not including the entire gamut of conditions affecting the diabetic foot.⁵ On the other hand, several classifications of conditions like cellulitis in adults have been proposed irrespective of the diabetic status and the site involved.^{3,6}

Amit Jain's classification of diabetic foot complications proposed in 2012 is a holistic approach to understanding diabetic foot. It includes all the lesions seen in a diabetic foot and them into 3 broad groups (infective, non infective and mixed).⁷

Amit Jain's principles and practises in diabetic foot, also, had tried to address sub types with further classifications. One such attempt is the new staging system for cellulitis in diabetic lower limbs proposed in 2014 (Table 1).8

Table 1: Amit Jain's staging of cellulitis in diabetic lower limbs.

Stages	Clinical description
Stage 1	Cellulitis without abscess or skin necrosis
Stage 2	Cellulitis with either localized abscess or skin necrosis
Stage 3	Necrotizing fasciitis without myonecrosis
Stage 4	Necrotizing fasciitis with myonecrosis

The proposed treatment strategy according to Amit Jain's stage of cellulitis includes (but not limited to) (Table 2).

Table 2: Treatment based on Amit Jain's stage of cellulitis.

Stages	Treatment guidelines
Stage 1	broad spectrum antibiotics, limb elevation, and crepe bandage. Monitor the patient daily
Stage 2	requires some form of surgical intervention, like drainage of abscess or debridement
Stage 3	extensive radical debridement of all the devitalized tissues/ amputation based on extensiveness
Stage 4	debridement and some form of amputation is invariably performed at this stage

Authors conducted a study on cellulitis in diabetic lower limbs staged according to Amit Jain's staging of cellulitis. The study aims to analyze cellulitis and its complications using Amit Jain's staging system. It also sought to predict the outcomes associated with cellulitis and surgical procedures done in them.

METHODS

The study was a cross sectional descriptive retrospective analysis and conducted in the Department of General Surgery at RajaRajeswari Medical College & Hospital (RRMCH) between April 2016 to March 2017. The study duration was for 1 year.

Inclusion criteria

- All patients admitted and treated for diabetic foot cellulitis in department of surgery in RRMCH were included in the study.
- Patients initially treated conservatively at other hospitals and subsequently referred to our department for further management were included.

Exclusion criteria

The following patients were excluded from the study.

- Patients who refused surgery or were discharged against advice.
- Patients treated in other speciality departments.
- Patients operated elsewhere.
- Patients with incomplete records

Statistical methods

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean \pm SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. P value P \leq 0.01 was considered strongly significant.

The following assumptions on data are made.

- 1. Assumption 1: Dependent variables should be normally distributed.
- 2. Assumption 2: Samples drawn from the population should be random, and 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. The Statistical software namely SPSS 18.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.⁹⁻¹²

RESULTS

The records of 62 patients were reviewed and only 39 patients were included in the study after they met the above inclusion criteria. There were 21 male patients and 18 females. Mean age of the patients in the study was 56 years (range: 30-80 years). Around 92.3% of the patients were above 40 years of age (Table 3). 38 patients in the study had single limb involvement. Only one patient was involved of both lower limbs with stage 1 cellulitis and was managed conservatively.

Table 3: Age distribution.

Age in years	No. of patients	Percentage (%)
30-40	3	7.7
41-50	9	23.1
51-60	14	35.9
61-70	11	28.2
>70	2	5.1
Total	39	100.0

Mean \pm SD: 56.00 \pm 10.65

Majority of our patients (74%) had diabetes mellitus (DM) of less than 10 years duration (Table 4). The correlation between the age of the patients (P=0.984) and duration of diabetes mellitus (P=0.264) with stage of cellulitis was checked and found to be statistically insignificant.

Table 4: Duration of Diabetes Mellitus (DM).

Duration of DM in years	No. of patients	(%)
1-2	10	25.6
3-5	3	7.7
6-10	16	41.0
11-15	5	12.8
16-20	4	10.3
>20	1	2.6
Total	39	100.0

Mean±SD: 7.82±5.93

21 patients (53.8%) in the study had associated co morbid conditions, with hypertension being the most common. There was one mortality in our study (2.6%, stage 4 cellulitis).

Around 13 patients (33.3%) were found to have stage 1 cellulitis, whereas 8 patients (20.5%) were in stage 4 category. Stage 2 cellulitis was the most common form in our study (41%) (Table 5).

Nearly 80% of the patients in the study underwent some form of surgery as the initial treatment. Remaining were managed conservatively with antibiotics (Table 6).

Table 5: Distribution of stages of cellulitis.

Stage of cellulitis	No. of patients	(%)
Stage 1	13	33.3
Stage 2	16	41.0
Stage 3	2	5.1
Stage 4	8	20.5
Total	39	100.0

Table 6: Initial treatment.

Initial treatment	No. of patients	(%)
Conservative	8	20.5
Surgical	31	79.5
Total	39	100.0

The need for the surgery and its relationship with stage of cellulitis was looked into. It was found that the need for surgery increases proportionately with the stage of cellulitis. All the patients with stage 2, 3 and 4 cellulitis underwent some form of surgical treatment. Majority of the patients with stage 1 cellulitis were managed conservatively (Table 7).

Table 7: Need for surgery in relation to stage of cellulitis.

Sur-	Stage of cellulitis						
gery done	Stage 1	Stage 2	Stage 3	Stage 4	Total		
No	8	0	0	0	8		
	(61.5%)	(0%)	(0%)	(0%)	(20.5%)		
Yes	5	16	2	8	31		
	(38.5%)	(100%)	(100%)	(100%)	(79.5%)		
Total	13	16	2	8	39		
	(100%)	(100%)	(100%)	(100%)	(100%)		

P<0.001**, significant, Fisher Exact test

Table 8: Type of surgery as initial treatment in relation to stage of cellulitis.

Trung of gungany ag	Stage of cell	lulitis			Total
Type of surgery as initial treatment	Stage 1 (n=13)	Stage 2 (n=16)	Stage 3 (n=2)	Stage 4 (n=8)	Total (n=39)
Debridement	1(7.7%)	16(100%)	2(100%)	5(62.5%)	24(61.5%)
Fasciotomy	4(30.8%)	0(0%)	0(0%)	0(0%)	4(10.3%)
Amputation	0(0%)	0(0%)	0(0%)	3(36.5%)	3(7.8%)

P<0.001**, significant, Fisher Exact test

Table 9: No. of surgical procedures in relation to stage of cellulitis.

	Stage of cel	llulitis			Total	
No. of surgical procedures	Stage 1 (n=13)	Stage 2 (n=16)	Stage 3 (n=2)	Stage 4 (n=8)	Total (n=39)	P value
Single Procedure	4(30.8%)	15(93.8%)	0(0%)	4(50%)	23(59%)	<0.001**
Multiple Procedure	1(7.7%)	1(6.2 %)	2(100%)	4(50%)	8(20.1%)	0.008**

**Chi-Square test/Fisher Exact test

	Table 10: Distribution of	amputation in rela	ation to stage of cellulitis.
--	---------------------------	--------------------	-------------------------------

	Stage of cel	llulitis	— Total			
Amputation	Stage 1 (n=13)	Stage 2 (n=16)	Stage 3 (n=2)	Stage 4 (n=8)	Total (n=39)	P value
Amputation	0(0%)	2(12.5%)	1(50%)	7(87.5%)	10(25.6%)	<0.001**
Major Amputation	0(0%)	1(6.3%)	1(50%)	5(62.5%)	7(17.9%)	<0.001**
Minor Amputation	0(0%)	1(6.3%)	0(0%)	2(25%)	3(7.7%)	0.276

Chi-Square test/Fisher Exact test

Debridement was the most common surgical procedure performed among the patients who underwent surgery as the initial treatment, (61.5%). Amputation was the initial treatment only in stage 4 cellulitis (Table 8). The patients who underwent surgical treatment were analyzed for the need of single or multiple procedures. It was found that patients with higher stages of cellulitis needed multiple procedures and it was statistically significant (Table 9).

Ultimately 10 patients needed amputation (25.6%). Of these 7 were minor (digit, metatarsal etc.) and 3 were major (above knee/below knee) amputations. None of the patients with stage 1 cellulitis needed amputation where as 87.5% of patients with stage 4 cellulitis underwent amputation. The need for amputation, especially major amputation, increased with the stage of cellulitis and was found to be statistically significant (Table 10).

DISCUSSION

Cellulitis in a diabetic lower limb is one of the most common infective complications seen in surgical practice. The condition carries a lot of morbidity and sometimes even mortality. In a populous developing country like India, the sheer number of diabetics and hence its infective complications make it a public health hazard. A proper classification of the disease is the first and most important step in tackling the menace. ¹³ Our study on diabetic lower limb cellulitis using Amit Jain's classification provided crucial insights into the disease.

Majority of the patients in our study were above 40 years of age. Mean age of the patients in the study was 56 years. This is comparable to a study conducted in southern china (n=527), where the mean age was 56.14 years. ¹⁴ In a study by Amit Jain, the average age for males was 57.8 years and for females it was 54.5 years. ¹⁵

Three fourth of our patients had diabetes for less than 10 years. 85% of patients in Amit Jain's study also had diabetes for less than 10 years. 15

Most of the patients had stage 2 cellulitis (41%), followed by stage 1 (33%) and stage 4 (20.5%) (Figure 1, 2, 3). There was no correlation between the age of the patients and duration of diabetes with the stage of the cellulitis. Similarly, in another study on diabetic lower limb

cellulitis, stage 2 was the most common stage of cellulitis noted (42.1%). ¹⁵



Figure 1: Cellulitis left lower limb. this is Amit Jain's stage 1 cellulitis.

Almost 80% of the patients underwent some form of surgery as the initial treatment. Considering 33% of patients had stage 1 cellulitis, which can be medically managed, this number is slightly higher. This again highlights the practise of the surgeons to err on the surgical side, resulting in unnecessary fasciotomies and debridements. Among the patients with stage 1 cellulitis, 38.5% underwent surgical treatment.



Figure 2: Cellulitis of right lower limb with necrosis and abscess over lateral malleolus. This is Amit Jain's Stage 2 cellulitis.



Figure 3: Necrotising fasciitis. This is Amit Jain's stage 3.

There was a statistically significant association between the need for surgery and the stage of cellulitis. All the patients with stage 2, 3 and 4 had surgical intervention. Amputation as an initial treatment was offered only in 1 patient with stage 4 cellulitis.

Debridement was the most common surgical procedure performed among the patients who underwent surgery as the initial treatment (61.5%). This is comparable to another study, the results of which showed that debridement is the most common surgical procedure (65.38%).¹⁵

The study also showed that, a patient with higher stage of cellulitis had more chances of undergoing multiple surgical procedures (repeat debridements, fasciotomy followed by debridement etc) compared to a patient with a lower stage of cellulitis. In a study conducted in 2011, majority of the patients needed multiple surgical procedures and the number increased with delay in the first surgery. If In a 10-year retrospective study by Sanchez et al, 40% of patients underwent reoperations for diabetic foot infections. In our study 20.1% of the patients needed multiple procedures.

Ultimately 25.6% of patients in the study needed amputation. None of the patients with stage 1 cellulitis needed amputation where as 87.5% of patients with stage 4 cellulitis underwent amputation. The need for amputation, especially major amputation, increased with the stage of cellulitis and was found to be statistically significant. In Amit Jain's study, approximately 8% of the patients needed amputation.¹⁵

The rate of amputations in a study on necrotizing soft tissue infections in diabetic feet by sanchez et al is as follows. In the necrotizing cellulitis group (n = 109), 8 (7.3%) major amputations were performed. In the necrotizing fasciitis group (n = 25), 13 (52%) major amputations were undertaken. In the myonecrosis group (n = 11), 6 (54.5%) major amputations were performed. 18

Amputation is done in 25–50% of the cases in a study by Anaya et al.¹⁹ In our study, the rate of major amputation among patients with necrotizing fasciitis and myonecrosis (stage 3 and 4) was 60% and is comparable with the above results.

Overall mortality in our study was 2.6% comparable to results from Amit Jain's study (3.85%).¹⁵ There was one mortality out of 10 patients with necrotising infections (stage 3 and 4) in our study (10%). A review on necrotising soft tissue infections by Sarkar B and Napolitano LM opined that mortality rate has decreased from 25-50% in past years, to 10-16% in recent years with aggressive surgical and medical management.²⁰ Currently, the reported mortality rate in National Surgical Quality Improvement Program in USA is around 12%.²¹ The mortality rates in studies conducted by Cuschieri et al, and Kobayashi et al, was 25% and 17% respectively.^{22,16}

CONCLUSION

Lower limb cellulitis and its local complications, still continues to be a major cause of morbidity and mortality in patients with diabetes. Our study shows that stage 2 cellulitis is the most common type of cellulitis seen in a hospital setting. Patients diagnosed with stage 1 cellulitis can and should be managed medically, avoiding unnecessary surgery, which we found to be 38.5% in this study. Debridement is the most common surgical procedure performed. Patients with higher stages of cellulitis are more likely to undergo surgical intervention, multiple surgeries and amputation (especially major amputation), which was found to be statistically significant.

It was that Amit Jain's staging of cellulitis for diabetic lower limb is simple and practical, which can be easily replicated in any clinical setting.

ACKNOWLEDGEMENTS

Authors would like to thank Dr. K.P. Suresh, Scientist (Biostatistics), National Institute of Veterinary Epidemiology and Disease Informatics (NIVEDI), Bangalore, for reviewing the research methodology and statistical results of the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the
Institutional Ethics Committee (No: RRMH/IEC/Research
– 14/2016-17)

REFERENCES

1. Clayton W, Elasy TA. A review of the pathophysiology, classification and treatment of foot ulcers in diabetic patients. Clin Diabetes. 2009;27(2):52-8.

- 2. Ahmed AA, Elsharief E, Alsharief A. The diabetic foot in the Arab world. J Diab Foot Comp. 2011;3(3): 55-61.
- 3. Lipsky BA, Berendt AR, Cornia PB, Pile JC, Peters EJD, Armstrong DG, et al. Infectious Diseases Society of America Clinical Practice Guideline for the Diagnosis and Treatment of Diabetic Foot Infections. CID. 2012;54:e134.
- 4. Koerner R, Johnson AP. J Antimicrobial Chemotherapy. 2011;66(2):232-4.
- Kalaivani V. Evaluation of Diabetic Foot Complications According to Amit Jain's Classification. JCDR. 2014;8(12):NC07-9.
- Eron LJ. Infections of skin and soft tissues: outcome of a classification scheme. Clin Infect Dis. 2000;31:287.
- 7. Jain AKC. A new classification of diabetic foot complications: A simple and effective teaching tool. J Diab Foot Comp. 2012;4(1):1-5.
- 8. Jain AKC. A new staging system for cellulitis in diabetic lower limbs-improving diabetic foot practice around the world. J Diab Foot Comp. 2014;6(2):48-53.
- Bernard Rosner. In: Fundamentals of Biostatistics, 5th Edition, Duxbury, 2000.
- Robert H Riffenburg. In: Statistics in Medicine, 2nd Edition, Academic press; 2005.
- Rao PSSS, Richard J. In: An Introduction to Biostatistics, A manual for students in health sciences, New Delhi: Prentice hall of India. 4th Edition: 2006.
- 12. Suresh KP, Chandrasekhar S. Sample Size estimation and Power analysis for Clinical research studies. Journal Human Reproduction Science. 2012;5(1):7-13.
- 13. Satterfield K. A guide to understanding the various wound classification systems. Podiatry Today. 2006;19(66):20.
- Li X, Chen Y, Gao W, Ouyang W, Wei J, Wen Z. Epidemiology and Outcomes of Complicated Skin and Soft Tissue Infections among Inpatients in Southern China from 2008 to 2013. PLoS ONE 2016;11(2):e0149960.
- 15. Jain AKC, Viswanath S. Evaluation and Management of Cellulitis and its Local

- Complications in Diabetic Lower Limb using the New Amit Jain's Staging System for Cellulitis-a retrospective study. SEAJCRR. 2015;4(2):1392-401.
- Kobayashi L, Konstantinidis A, Shackelford S, Chan LS, Talving P, Inaba K, et al. Necrotizing soft tissue infections: delayed surgical treatment is associated with increased number of surgical debridements and morbidity. J Trauma. 2011 Nov;71(5):1400-5.
- 17. Aragon-Sanchez J, Lazaro-Martinez JL, Molines-Barroso R, Garcia Alvarez Y, Quintana-Marrero Y, Hernandez-Herrero MJ. Revision surgery for diabetic foot infections: giving another chance to the patient. Int J Low Extrem Wounds. 2013;12:146-51.
- 18. Aragón-Sánchez J, Quintana-Marrero Y, Lázaro-Martínez JL, Hernández-Herrero MJ, García-Morales E, Beneit-Montesinos JV. Necrotizing soft-tissue infections in the feet of patients with diabetes: outcome of surgical treatment and factors associated with limb loss and mortality. Int J lower Extremity Wounds. 2009 Sep;8(3):141-6.
- 19. Anaya DA, McMahon K, Nathens AB, Sullivan SR, Foy H, Bulger E. Predictors of mortality and limb loss in necrotizing soft tissue infections. Archives of Surgery. 2005;140(2):151-57.
- 20. Sarkar B, Napolitano LM. Necrotizing soft tissue infections. Minerva Chir. 2010;65(3):347-62.
- 21. Mills MK, Faraklas I, Davis C, Stoddard GJ, Saffle J. Outcomes from treatment of necrotizing soft-tissue infections: results from the National Surgical Quality Improvement Program database. Am J Surg. 2010;200(6):790-6.
- 22. Cuschieri J. Necrotizing soft tissue infection. Surg Infect (Larchmt). 2008;9(6):559-62.

Cite this article as: Gopal S, Santosh MP. Analysis of cellulitis in diabetic lower limb along with its local complications using Amit Jain's staging system: a cross sectional descriptive study. Int Surg J 2017;4:3915-20.