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To evaluate transmetatarsal amputation in diabetic foot through the Amit Jain's system of practice – An experience from 2 different centre's

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Abstract

The aim of this study was to evaluate trans metatarsal amputation (TMA) done in diabetic foot through Amit Jain's universal classification and scoring system and assess major amputations done in them. We conducted a descriptive retrospective analysis from 2 center's namely Amit Jain's Institute of Diabetic Foot &Wound Care at Brindhavvan Areion Hospital and at Department of surgery, Raja Rajeswari medical college, Bengaluru, India. The study period was from January 2017 to June 2018. 15 patients were recruited in the study with 73.3% of them being males. Around 20 % of them were above 70 years of age. Majority of patients who underwent TMA had open stump and it had significant association with duration of diabetes. Specialist diabetic foot surgeon had significant propensity to close the stump after trans metatarsal amputation (P<0.001). Patients who ended up in major amputation after TMA had a significant Amit Jain's surgical score of 16 and above (P-0.010). Type 1 diabetic foot complicationswere the most common cause for trans metatarsal amputation in diabetic foot with abscess being the commonest pathological lesion in this series. This study on trans metatarsal amputation in diabetic foot is uniquely done through Amit Jain's system of practice for diabetic foot which utilizes a simple descriptive universal classification that categorizes variety of lesions in diabetic foot into 3 tier system and through Amit Jain's scoring system that predicts major amputation in diabetic foot thereby abiding the law of classification that suggests utilizing combination of classifications for diabetic foot for a better analysis.

Keywords: Diabetic foot, amputation, abscess, wet gangrene, ulcer

Introduction

With the rise in the incidence of diabetes mellitus, there is also rise in diabetes related complications like stroke, blindness, renal failure, amputations, etc [1]. The diabetics are 25 times more at the risk of a limb amputation compared to non diabetics [2]. Amputation of the limb has significant morbidity and mortality apart from the cost [3]. This procedure has significant emotional trauma to the patient and entire family [3].

Trans metatarsal amputation (TMA) is a commonly performed procedure that was first described by Bernard and Huete in 1855 and it was popularized by Mc Kittrick in 1949 [3, 4]. Trans metatarsal amputation is a limb salvage procedure that maintains limb function and allows the patients to ambulate without any prosthesis [5].

The aim of the study was to analyze and study the causes of trans metatarsal amputation done in diabetic foot through the Amit Jain's universal classification (Figure 1) which is a simple, easy to remember 3 tier classification that addresses the diabetic foot triad efficiently and through Amit Jain's surgical scoring system for diabetic foot complication (Table 1) and to assess the proximal amputation being done in these patients through the Amit Jain's system of practice [6-9].

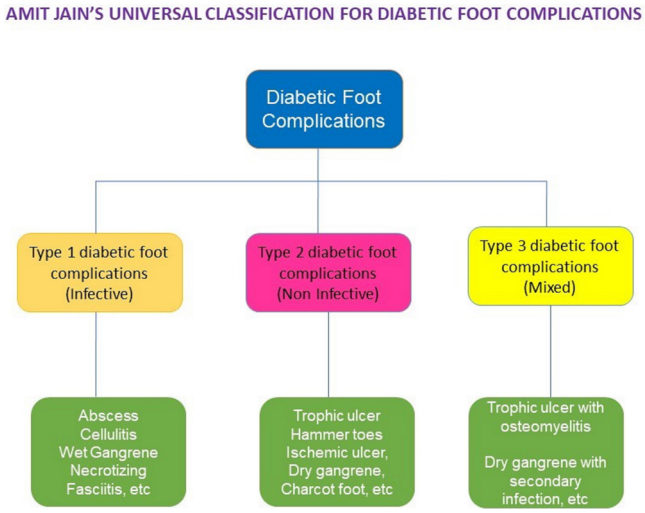

Figure 1. Amit Jain's universal classification for diabetic foot complication. This is a simple 3 tier descriptive classification encompassing all common lesions seen in the diabetic foot worldwide

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Table 1. Amit Jain's surgical scoring system for diabetic foot complication

SL NO	CHARACTERISTICS	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	

Material and Methods

A retrospective descriptive study was conducted wherein we recruited patients from two center's namely Amit Jain's Institute of Diabetic Foot and Wound Care, Brindhavvan Areion Hospital and Department of surgery, Raja Rajeswari Medical College. The institutional ethics committee clearance was obtained for this study [RRMCH-IEC/05/2017-18]

The study period was fromJan 2017 to June 2018.

Inclusion criteria:

• All diabetic foot patients who underwent trans metatarsal amputation were studied

Exclusion criteria:

• Transmetatarsal amputation done due to road traffic accident
• Patient's operated elsewhere first for TMA and then came for re-surgeries
• Incomplete records/data

Data Analysis [10, 11, 12]

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

Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Leven`s test for homogeneity of variance has been performed to assess the homogeneity of variance. 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. 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 also reported.

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 15 patients were included in this study. Most patients were males (73.3%) in this study.

Majority of the patients were in 40 to 50 years age group (33.3%) followed by 61 to 70 years (26.7%). 20% of them were above 70 years of age, 13.3% were in 51 to 60 years and 6.7% were less than 40 years. 46.7% had diabetes duration of less than 6 years (Table 2).

Table 2. Duration of diabetes mellitus distribution

Duration of DM	No. of patients	Percentage (%)
<6	7	46.7
6-12	3	20.0
12-24	4	26.7
>24	1	6.7
Total	15	100.0

53.3% of them had open stump after trans metatarsal amputation whereas 46.7% had closed stump.

There was no correlation of age, gender, side of foot, underlying pathology, presence of peripheral vascular disease or osteomyelitis and re-surgeries with stump status although some association was seen with duration of diabetes mellitus wherein 75% of patients stump were open stump in patients in whom diabetes was less than 6 years duration (Table 3).

Table 3. Association of clinical variables according to stump status of patients studied

Variables	Stump status		Total (n=15)	P value
	Open (n=8)	Closed n=7)		
Age in years				
<40	1(12.5%)	0(0%)	1(6.7%)	
40-50	4(50%)	1(14.3%)	5(33.3%)	
51-60	1(12.5%)	1(14.3%)	2(13.3%)	0.543
61-70	1(12.5%)	3(42.9%)	4(26.7%)	
71-80	1(12.5%)	2(28.6%)	3(20%)	
Gender				
Male	5(62.5%)	6(85.7%)	11(73.3%)	0.569
Female	3(37.5%)	1(14.3%)	4(26.7%)	
Duration of DM				
<6	6(75%)	1(14.3%)	7(46.7%)	
6-12	0(0%)	3(42.9%)	3(20%)	0.024*
12-24	1(12.5%)	3(42.9%)	4(26.7%)	
>24	1(12.5%)	0(0%)	1(6.7%)	
Side of Foot				
Right	5(62.5%)	4(57.1%)	9(60%)	1.000
Left	3(37.5%)	3(42.9%)	6(40%)	
Pathology				
Abscess	3(37.5%)	2(28.6%)	5(33.3%)	
Wet gangrene	1(12.5%)	3(42.9%)	4(26.7%)	0.720
Dry gangrene	1(12.5%)	0(0%)	1(6.7%)	
Infected ulcer	3(37.5%)	2(28.6%)	5(33.3%)	
PVD				
Yes	1(12.5%)	0(0%)	1(6.7%)	1.000
No	7(87.5%)	7(100%)	14(93.3%)	
Osteomyelitis				
Yes	2(25%)	4(57.1%)	6(40%)	0.315
No	6(75%)	3(42.9%)	9(60%)	
Resurgeries				
Yes	3(37.5%)	2(28.6%)	5(33.3%)	1.000
No	5(62.5%)	5(71.4%)	10(66.7%)	

Significant association (P<0.001**) was seen between stump status and hospital where the patients were operated (Table 4). All patients in group A had closed their stump closed after trans-metatarsal amputation whereas patients in group B had their stump left open (Guillotine). Further, the specialist foot surgeon had significant propensity (Figure 2) to closed the stump after TMA (P<0.001**). No association was seen between stump status with type of diabetic foot complication, scoring of the foot, co morbidities like hypertension, chronic kidney disease or ischemic heart disease, multiple surgeries or subsequent major amputation or past amputation.

No association of major amputation was seen with type of diabetic foot complication, operating surgeon or hospital, co morbidities, multiple surgeries or past history of amputation (Table 5) although it was seen that all patients with Amit Jain's surgical scoring of more than 16 (High risk and above categories), ended up in major amputation significantly (P-0.010**) (Figure 3). Thus, the optimal cut off point for major amputation was observed to be 16 and above with an AUC of 1 (Figure 4), indicating a good accuracy of Amit Jain's surgical scoring system with a sensitivity, specificity, positive and negative predictive values of 100%.

There was no association between age, gender, diabetes mellitus duration, side of foot involved, pathology, presence of underlying osteomyelitisor peripheral vascular disease and stump status with major amputation (Table 6) although some association was noted between re-surgeries and major amputation (P-0.095+).

No association existed between presence of Peripheral vascular disease (PVD) with scoring and subsequent major amputation in this Trans metatarsal amputation series (Table 8).

Table 4. Association of clinical variables according to stump status of patients studied

Variables	Stump status		Total (n=15)	P value
	Open (n=8)	Closed n=7)		
Hospital				
Group A	0(0%)	7(100%)	7(46.7%)	<0.001**
Group B	8(100%)	0(0%)	8(53.3%)	
Operating surgeon				
Specialist foot surgeon	0(0%)	7(100%)	7(46.7%)	<0.001**
General surgeon	8(100%)	0(0%)	8(53.3%)	
Type of diabetic foot complications				
Type 1	4(50%)	5(71.4%)	9(60%)	
Type 2	1(12.5%)	0(0%)	1(6.7%)	1.000
Type 3	3(37.5%)	2(28.6%)	5(33.3%)	
Amit Jain's scoring				
<10	2(25%)	1(14.3%)	3(20%)	
10-15	4(50%)	6(85.7%)	10(66.7%)	0.452
16 & Above	2(25%)	0(0%)	2(13.3%)	
Comorbidities				
Yes	3(37.5%)	6(85.7%)	9(60%)	0.119
No	5(62.5%)	1(14.3%)	6(40%)	
Hypertension				
Yes	3(37.5%)	6(85.7%)	9(60%)	0.119
No	5(62.5%)	1(14.3%)	6(40%)	
CKD				
Yes	1(12.5%)	2(28.6%)	3(20%)	0.569
No	7(87.5%)	5(71.4%)	12(80%)	
IHD				
Yes	0(0%)	2(28.6%)	2(13.3%)	0.200
No	8(100%)	5(71.4%)	13(86.7%)	
Multiple Surgeries				
Yes	5(62.5%)	1(14.3%)	6(40%)	0.119
No	3(37.5%)	6(85.7%)	9(60%)	
Major Amputation				
Yes	2(25%)	0(0%)	2(13.3%)	0.467
No	6(75%)	7(100%)	13(86.7%)	
Past History Amputation				
Yes	1(12.5%)	0(0%)	1(6.7%)	1.000
No	7(87.5%)	7(100%)	14(93.3%)	

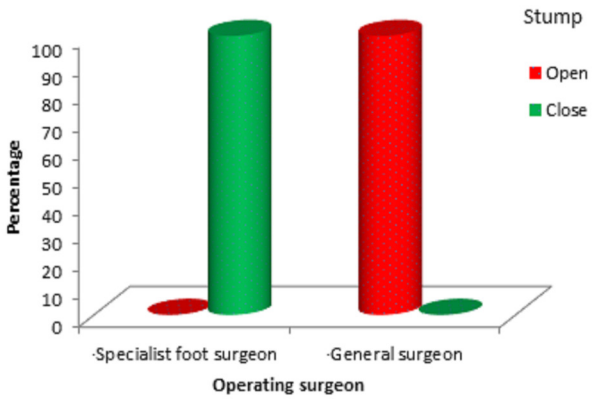

Figure 2. Stump status after TMA among surgeons

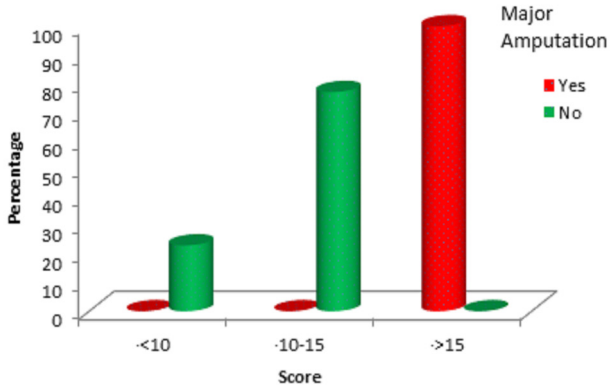

Figure 3. Association of Amit Jain's scoring with major amputation

Table 5. Association of clinical variables with major amputations

Variables	Major Amputation		Total (n=15)	P value
	Yes (n=2)	No (n=13)		
Hospital				
Group A	0(0%)	7(53.8%)	7(46.7%)	0.467
Group B	2(100%)	6(46.2%)	8(53.3%)	
Operating surgeons				
Specialist foot surgeon	0(0%)	7(53.8%)	7(46.7%)	0.467
General surgeon	2(100%)	6(46.2%)	8(53.3%)	
Type of diabetic foot complications				
Type 1	2(100%)	7(53.8%)	9(60%)	
Type 2	0(0%)	1(7.7%)	1(6.7%)	0.571
Type 3	0(0%)	5(38.5%)	5(33.3%)	
Amit Jain's scoring system				
<10 (Low risk)	0(0%)	3(23.1%)	3(20%)	
10-15 (Moderate risk)	0(0%)	10(76.9%)	10(66.7%)	**0.010****
16 & above (High risk & Above)	2(100%)	0(0%)	2(13.3%)	
Co morbidities				
Yes	1(50%)	8(61.5%)	9(60%)	1.000
No	1(50%)	5(38.5%)	6(40%)	
Hypertension				
Yes	1(50%)	8(61.5%)	9(60%)	1.000
No	1(50%)	5(38.5%)	6(40%)	
CKD				
Yes	0(0%)	3(23.1%)	3(20%)	1.000
No	2(100%)	10(76.9%)	12(80%)	
IHD				
Yes	0(0%)	2(15.4%)	2(13.3%)	1.000
No	2(100%)	11(84.6%)	13(86.7%)	
Multiple Surgeries				
Yes	2(100%)	4(30.8%)	6(40%)	0.143
No	0(0%)	9(69.2%)	9(60%)	
Past History Amputation				
Yes	0(0%)	1(7.7%)	1(6.7%)	1.000
No	2(100%)	12(92.3%)	14(93.3%)	

Table 6. Association of clinical variables with major amputations

Variables	Major Amputation		Total (n=15)	P value
	Yes (n=2)	No (n=13)		
Age in years				
<40	0(0%)	1(7.7%)	1(6.7%)	0.362
40-50	0(0%)	5(38.5%)	5(33.3%)	
51-60	1(50%)	1(7.7%)	2(13.3%)	
61-70	1(50%)	3(23.1%)	4(26.7%)	
71-80	0(0%)	3(23.1%)	3(20%)	
Gender				
Male	1(50%)	10(76.9%)	11(73.3%)	0.476
Female	1(50%)	3(23.1%)	4(26.7%)	
Duration of DM (years)				
<6	1(50%)	6(46.2%)	7(46.7%)	0.832
6-12	0(0%)	3(23.1%)	3(20%)	
12-24	1(50%)	3(23.1%)	4(26.7%)	
>24	0(0%)	1(7.7%)	1(6.7%)	
Side of Foot				
Right	1(50%)	8(61.5%)	9(60%)	1.000
Left	1(50%)	5(38.5%)	6(40%)	
Pathology				
Abscess	2(100%)	3(23.1%)	5(33.3%)	0.381
Wet gangrene	0(0%)	4(30.8%)	4(26.7%)	
Dry gangrene	0(0%)	1(7.7%)	1(6.7%)	
Infected ulcer	0(0%)	5(38.5%)	5(33.3%)	
PVD				
Yes	0(0%)	1(7.7%)	1(6.7%)	1.000
No	2(100%)	12(92.3%)	14(93.3%)	
Osteomyelitis				
Yes	0(0%)	6(46.2%)	6(40%)	0.486
No	2(100%)	7(53.8%)	9(60%)	
Resurgeries				
Yes	2(100%)	3(23.1%)	5(33.3%)	**0.095+**
No	0(0%)	10(76.9%)	10(66.7%)	
Stump status				
Open	2(100%)	6(46.2%)	8(53.3%)	0.467
Closed	0(0%)	7(53.8%)	7(46.7%)	

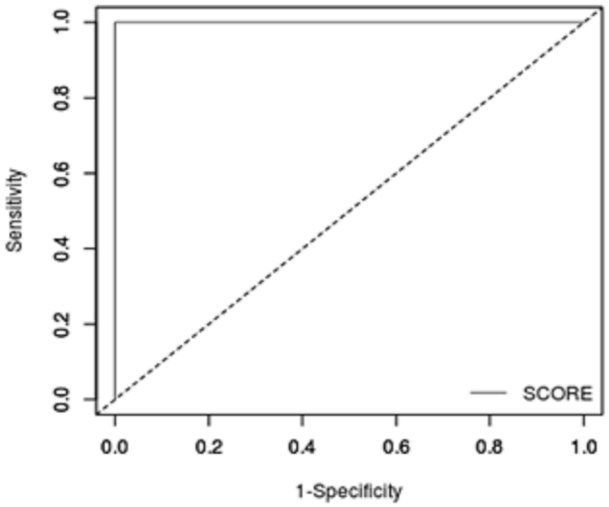

Figure 4. Receiver operating characteristic (ROC) curve for Amit Jain's surgical scoring system (AUC of 1)

Figure 5. Patient who had undergone TMA with debridement for type 1 diabetic foot complication (wet gangrene) and it later ended up in major amputation. His score was 26 (Gangrene 2 + Ulcer 4 + Previous amputation 2 + Skin necrosis 4 + Pus 6 + Cellulitis 6 + Surgeon factor 2)

Table 7. Association of clinical variables with Amit Jain's classification for diabetic foot complication

Variables	Type of diabetic foot complications			Total (n=15)	P value
	Type I (n=9)	Type II (n=1)	Type III (n=5)		
Stump status					
Open	4(44.4%)	1(100%)	3(60%)	8(53.3%)	1.000
Closed	5(55.6%)	0(0%)	2(40%)	7(46.7%)	
Amit Jain's scoring					
<10	1(11.1%)	0(0%)	2(40%)	3(20%)	
10-15	6(66.7%)	1(100%)	3(60%)	10(66.7%)	0.706
16 & above	2(22.2%)	0(0%)	0(0%)	2(13.3%)	
Major Amputation					
Yes	2(22.2%)	0(0%)	0(0%)	2(13.3%)	0.571
No	7(77.8%)	1(100%)	5(100%)	13(86.7%)	
Multiple Surgeries					
Yes	4(44.4%)	0(0%)	2(40%)	6(40%)	1.000
No	5(55.6%)	1(100%)	3(60%)	9(60%)	

Table 8. Showing association of clinical variables with peripheral vascular disease

Variables	PVD		Total (n=15)	P value
	Yes (n=1)	No (n=14)		
Score				
<10	0(0%)	3(21.4%)	3(20%)	
10-15	1(100%)	9(64.3%)	10(66.7%)	1.000
16 & above	0(0%)	2(14.3%)	2(13.3%)	
Major Amputation				
Yes	0(0%)	2(14.3%)	2(13.3%)	1.000
No	1(100%)	12(85.7%)	13(86.7%)	

Discussion

Trans metatarsal amputation (TMA) is a type 1-foot amputation that allows significant weight bearing residuum [13, 14]. Foot amputations are classified into 3 types based on Amit Jain's SCC classification for minor amputation and transmetatarsal amputation belongs to type 1-foot amputation which are simple amputation [13]. Further, it has a lower mortality compared to major amputations like above knee or below knee amputations [15].

The common reasons for Trans metatarsal amputation in diabetic foot includes gangrene, abscess, non-healing ulcers etc. In Jain et al series [16], wet gangrene accounted for 52% of cases resulting in trans metatarsal amputation. 76% of patients who underwent trans metatarsal amputation had type 1 diabetic foot complications. In their series, 20% had osteomyelitis [16]. In Thomas et al series, 76% of TMA patients had gangrene and 7.31% of them having osteomyelitis [17]. In Humphrey et al series, 17% patients who underwent TMA had gangrene and remaining being done for non-healing ulcer [18].

In our series, 60% of patients who underwent TMA had type 1 diabetic foot complications with abscess being commonest (33.3%) followed by wet gangrene. 33.3% of patients with TMA had type 3 diabetic foot complications (non-healing ulcer). 40% had underlying osteomyelitis and 6.7% had peripheral vascular disease.

Different series have different approach towards closure of TMA stump. In Thomas et al series (17), 46% of TMA had primary closure of their stump. In Jain et al series (16), 88% of TMA stump were left open. In Toursarkissian et al series, 45.5% stumps were left open to granulate [19]. Interestingly in our series, it was seen that 46.7% of TMA had their stump closed. Also, it was seen that the propensity to close the stump after TMA was significantly more at specialtycenter when TMA was done by diabetic foot specialist.

In spite of TMA being a salvage procedure, it has its own deal of problems. The biggest issue with TMA is wound healing. Wound dehiscence, non-healing, stump infection, flap necrosis, etc are various acute complications one can encounter after TMA. In Series of Dunkel et al, it was observed that 16.3% had wound dehiscence and 21.8% had stump infection [20]. These complications often result in re-surgeries. In one series, 82% of patients after TMA required re-surgeries [21]. In Kaiser et al series [22], the revision surgeries were 40% with reasons being delayed wound healing, new soft tissue infections, gangrene, persistent osteomyelitis or presence of ulceration. In our series, re-surgeries were done in 33.3% of patients with TMA.

Proximal amputation is another concern after TMA. In Kaiser et al series, only 14% required major amputation [22]. In Jain et al series [16], 20% of TMA patients ended up in major amputation in same hospitalization with most of them having a score of 16 and above belonging to high risk and above categories as per Amit Jain's surgical scoring system (Figure 5). In Toursarkissian et al series [19], 31.8% of the patients underwent major amputation after TMA. In our current series, 13.3% of the patients with TMA underwent major amputation in same admission. All the patients who ended up with major amputation had score of 16 and above (significant association) being in high risk category& above of Amit Jain's surgical scoring system and further there was significant association with re-surgeries. Although, the mortality after TMA ranges from 2-3% [16, 17], we had no in hospital mortality in this series.

Conclusion

Trans metatarsal amputation in diabetic foot is a good limb salvage option that provides an opportunity to patient to walk on his own residual foot. Type 1 diabetic foot complication are the most common cause for TMA with abscess being the commonest pathological lesion in this study. The specialist diabetic foot surgeon and specialty center have significant propensity to close the TMA stump. 13.3% of the TMA's ended in major amputation in same hospitalization and it was significantly associated with Amit Jain's score of 16 & above and also with re-surgeries. (Amit Jain's surgical scoring has an excellent sensitivity and specificity in predicting the risk of major amputation)

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Conflict of interests
The authors declare that they have no conflict of interest.

Financial Disclosure
All authors declare no financial support.

Ethical approval
hics committee approval received from the Institutional Ethics Committee of the hospital (RRMCH-IEC/05/2017-18)

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