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Diabetic foot and its complications: A cross sectional study in rural medical college

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Abstract
Objectives of the study: To understand the pathology of diabetic foot and relative distribution of this condition according to age, sex, among diabetic patients. To study the benefit and outcome of the different treatment modalities for diabetic foot. To reduce the risk of lower limb complications in people with diabetes by strict diabetic control, through debridement, meticulous dressing, and appropriate antibiotic therapy. To identify and educate those at high risk to prevent foot lesions developing and early detection of problems and the need for rapid help.
Methods: This study was conducted comprising of 100 patients of diabetic foot in the department of general surgery at Trichy SRM Medical College and Hospital, Trichy during the period of Jan 2020 to Jun 2021.
Results: Commonest presenting lesion was ulcers (44%), followed by gangrene (24%) and cellulitis (20%). Commonest site of the lesion was dorsum of the foot (32%), followed by fore foot (28%), and toes (22%). Trivial trauma is the initiating factor in more than half of the cases. More than half of the patients 82% had infection. Most common microorganism grown from culture was *Staphylococcus aureus* (30%), 28(28%) patients were treated with wound debridement, 18(18%) patients underwent major amputation. Prognosis was good in 72(72%) patients. 2(2%) patient died due to septicemia.
Conclusion: Diabetic patients at risk for foot lesions must be educated about risk factors. The multidisciplinary team approach to diabetic foot disorders has been demonstrated as the optimal method to achieve favorable rates of limb salvage in the high-risk diabetic patient. Infection in a diabetic foot is potentially limb-threatening and always requires urgent diagnostic and therapeutic attentions.

Keywords: Diabetes, foot ulcers, neuropathy, ischemia

Introduction
Diabetes is a lifelong problem, and the incidence of diabetic foot complications increases with age and duration of the disease.
Ulceration, infection, gangrene, and amputation are significant complications of the disease. One of the most common complications of diabetes in the lower extremity is the diabetic foot ulcer. An estimated 15% of patients with diabetes will develop a lower extremity ulcer during the course of their disease. Charcot foot, which of itself can lead to limb-threatening disorders, is another serious complication of long-standing diabetes. These complications frequently result in extensive morbidity, repeated hospitalizations, and mortality.
Risk factors identified include peripheral neuropathy, vascular disease, limited joint mobility, foot deformities, abnormal foot pressures, minor trauma, a history of ulceration or amputation, and impaired visual acuity. Diabetic foot infections are frequently polymicrobial in nature. Hyperglycemia, impaired immunologic responses, neuropathy, and peripheral arterial disease are the major predisposing factors leading to limb-threatening diabetic foot infections. Not all foot complications can be prevented, dramatic reductions in frequently have been achieved by taking a multidisciplinary approach to patients. The emulation of the diabetic foot involves careful assimilation of the patient's history and physical findings with the results of necessary diagnostic procedures. Early detection of foot pathology, especially in high risk patients, can lead to earlier intervention and thereby reduce the potential for hospitalization and amputation.
Amputation of the foot may be indicated when neuropathy, vascular disease, and ulcerative deformity have led to soft tissues necrosis, osteomyelitis, uncontrollable infection or intractable pain. Local treatment of the ulcer consists of repeated debridement and dressing. Simple surgeries like split skin grafting or minor toe amputations.

Aims and Objectives

- To study the clinical pattern of foot infections in diabetic patients.
- To analyze the risk factors leading to complication in diabetic foot infection.
- To study the outcome of treatment modalities and suggest a patient friendly hospital management strategy for diabetic foot.
- To educate the patient about taking care of feet and preventive care.

Materials and Methods

This study was conducted comprising of, 100 patients of diabetic foot in the department of general surgery at Trichy SRM Medical College and Hospital, Trichy. During the period of Jan 2020 to Jun 2021.

Method of collection of data

- Detailed history taking.
- Thorough physical examination.
- Routine investigations.
- Relevant special investigations.
- Choosing the appropriate line of treatment.
- Assessment of patients following treatment at regular intervals in comparison to his/her pre-treatment with regards to symptoms.

All patients are studied and clinical findings are recorded as per proforma case sheet data analyzed and necessary investigations done as per required and treatment given. Predisposing factors, complications, treatment and sequel are studied, analyzed Stand discussed.

Inclusion criteria

- All patients with diabetes mellitus suffering from foot ulcers and infections are included in the study.
- Age group of the patients: all age groups are included in the study.
- Patients with known past history of diabetes are also included.
- Patients with gangrenous foot, complicated by diabetes are included in the study.

Exclusion criteria

- Patients with foot infections without diabetes mellitus are excluded.
- Patients with gangrene foot of etiology other than infection of foot complicated by diabetes are excluded.
- Patients whose treatment could not be completed due to non compliance are excluded.
- Incidental diagnosis of diabetes on admission.

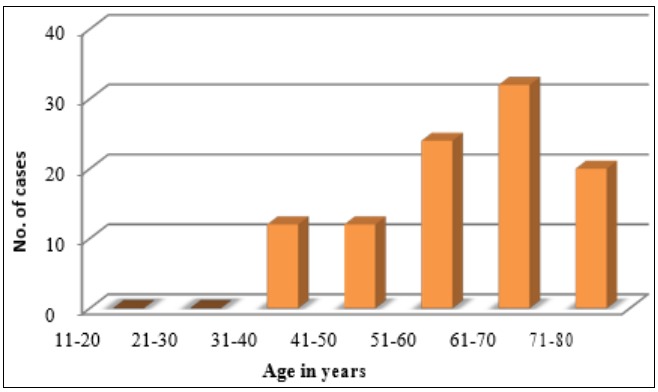
Observation and results

An analysis of 100 cases of diabetic foot was done. These cases were admitted and treated in different surgical units in Trichy SRM Medical College and Hospital, TRICHY during the period of Jan 2020 to Jun 2021.

Table 1: Age distribution

Age (Years)	No. of Patients	Percentage
11-20	0	0
21-30	0	0
31-40	12	12
41-50	12	12
51-60	24	24
61-70	3 2	32
71-80	20	20
Total	100	100

Of 100 cases studied, most of the diabetic patients with foot lesions were in the age group of 61-70 (32%) followed by 51-60 (24%). The youngest has 31 years came with complaints of abscess over the (R) fore foot and the oldest was 80 years admitted for cellulitis of (R) whole fore foot.

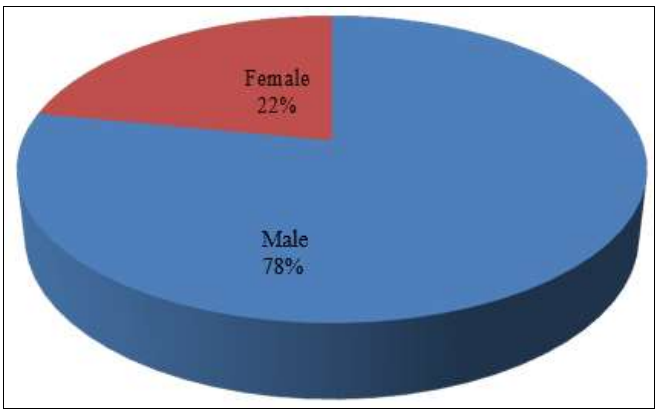


Graph 1: Age distribution

Table 2: Sex distribution

Sex	No. of Patients	Percentage
Male	78	78
Female	22	22

Out of 100 cases studied, there was a marked male predominance in occurrence of diabetic foot lesion.
78 (78%) were male patients and 22 cases females patients. Ratio of 1 Male: Female is 3.54: 1

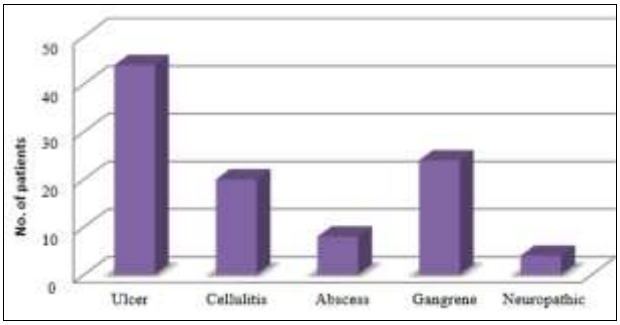


Graph 2: Sex distribution

Table 3: Clinical presentation

Clinical Presentation	No. of Patients	Percentage
Ulcer	44	44
Cellulitis	20	20
Abscess	8	8
Gangrene	24	24
Neuropathic Ulcer	4	4

Out of 100 SG" cases, 22 (44%) cases presented with ulcers, 10 (20%) cases with cellulitis 16 (16%) of cases abscess, 24 (24%) of cases gangrene and (4%) of cases Neuropathic ulcer.

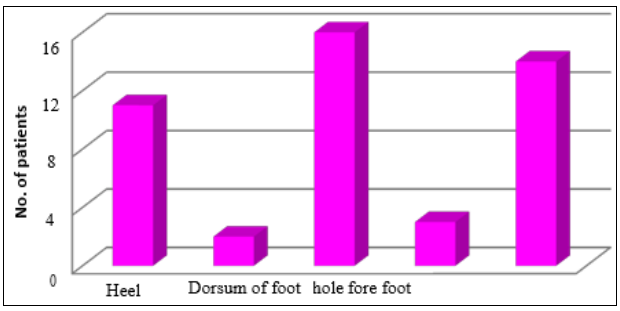


Graph 3: Clinical presentation

Table 4: Site of lesion

Site of Lesion	No. of Patients	Percentage
Toes	22	22
Heel	4	4
Dorsum of foot	32	32
Plantar foot	18	18
Whole fore foot	28	28

The most common site of lesion in the diabetic foot was dorsum of foot which was in about 32 patients (32%).
Then whole fore foot which comprised about 14 cases (28%). The least was heel which was about 4 (4%) patients.

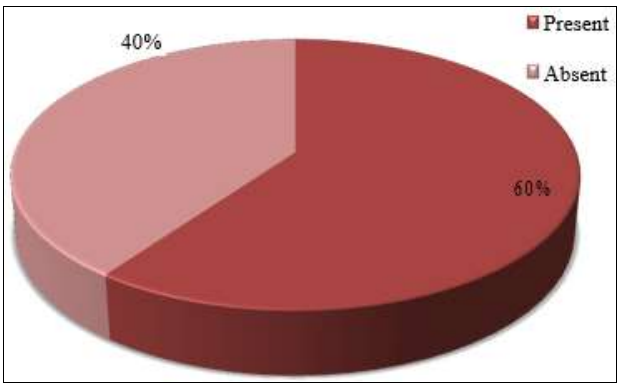


Graph 4: Site of lesion

Table 5: History of trauma

History of Trauma	No. of Patients	Percentage
Present	60	60
Absent	40	40

Out of the 100 cases studied 60 patients (60%) not had history of trauma and 40 patients (40%) not had history of trauma.

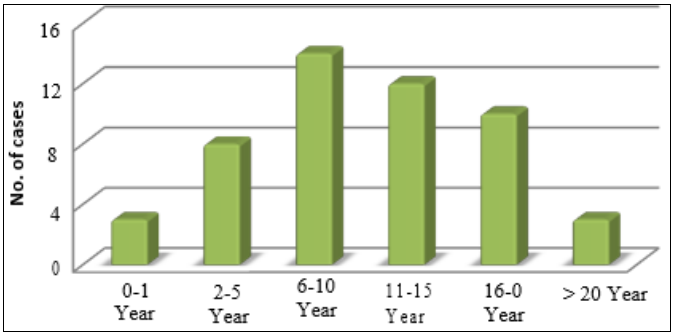


Graph 5: History of trauma

Table 6: Duration of DM

Duration of DM in Year	No. of Patients	Percentage
0-1 Year	6	6
2-5 Year	16	16
6-10 Year	28	28
11-15 Year	24	24
16-20 Year	20	20
> 20 Year	6	6

Most of the patients had diabetes duration for about 6-10 years (28%). One patient had history of diabetes for only 4 months and a 80 years old male patients ^' came with past history of diabetes with duration of 24 years.

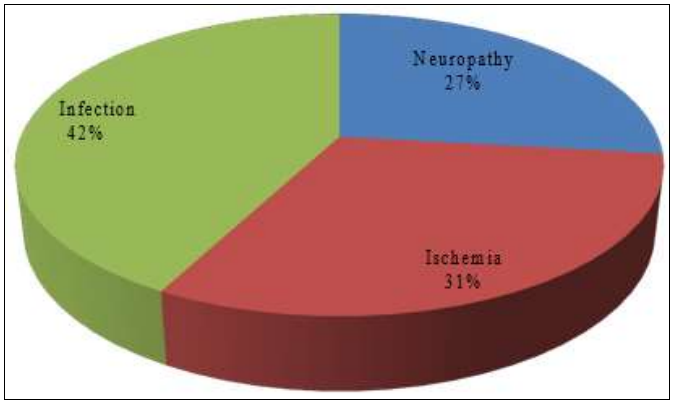


Graph 6: Duration of DM

Table 7: Complication

Duration of DM in Years	No. of Patients	Percentage
Neuropathy	52	52
Ischemia	60	60
Infection	82	82

In the present study 52 (52) patients presented with neuropathy. Ischemia was seen in 60 patients and there was infection in 82 (82) patients. The above table shows that multiple complications can be presented in a single patients with diabetic foot.

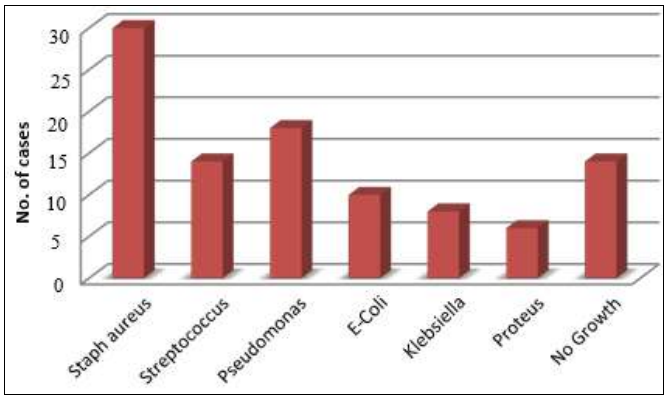


Graph 7: Complication

Table 8: Culture and sensitivity

Organisms	No. of Patients	Percentage
Staph aureus	30	30
Streptococcus	14	14
Pseudomonas	18	18
E-Coli	10	10
Klebsiella	8	8
Proteus	6	6
No Growth	14	14

The most common microorganism grown on culture of pus was *staphylococcus aureus* in 30 (30%) patients followed by pseudomonas 18 (18%), streptococcus 14 (14%), E-coli 10 (10%), Klebsiella 8(8%), and Proteus 6 (6%). In 14 (14%) patients there was no growth seen on culture some cultures yielded more than one type of bacteria.

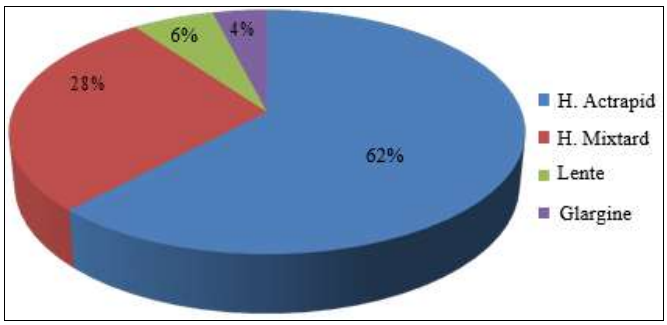


Graph 8: Culture and sensitivity

Table 9: Types of insulin

Type of Insulin	No. of Patients	Percentage
H. Actrapid	62	62
H. Mixtard	28	28
Lente	6	6
Glargine	4	4

The most common form of insulin used on the admission was H. Actrapid in 62(62%), patients and in (4%) patients glargine was used which was the least. Other types of insulin used were H. Mixtard and H. Actrapid.

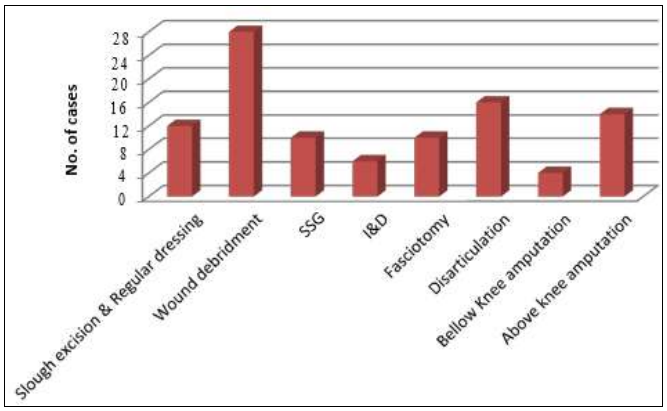


Graph 9: Types of insulin

Table 10: Treatment

Operative Procedure	No. of Patients	Percentage
Slough excision & Regular dressing	12	12
Wound debridement	28	28
SSG	10	10
I&D	6	6
Fasciotomy	10	10
Disarticulation	16	16
Bellow Knee amputation	4	4
Above knee amputation	14	14

Out of 100 patients treated 12 (12%) patients were managed conservatively by / slough excision and regular dressing with antibiotics with diabetic control. 28 (28%) patients were treated with wound debridement, ^(10%) patients treated with SSG, (6%) patients underwent I & D for abscess and, 5(10%) patients underwent J fasciotomy and 6 (16%) patients presented with gangrene of toes and phalanges were M treated with disarticulation. 4(4%) patients underwent below knee amputation and 14 (14%) patients were above knee amputation. In most of the cases, limb was salvaged by conservative treatment and minor computations.

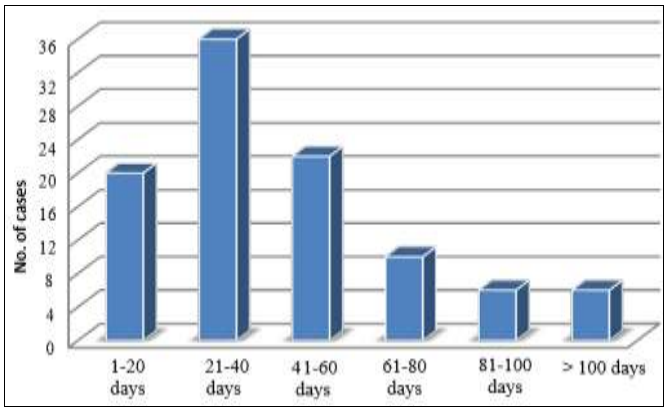


Graph 10: Treatment

Table 11: Duration of hospital stay

Hospital Stay	No. of Patients	Percentage
1-20 days	20	20
21-40 days	36	36
4 1-60 days	22	22
61-80 days	10	10
81-100 days	6	6
> 100 days	6	6

In this study minimum stay in the hospital was 10 days and maximum was 150/5l days. The most common duration of hospital stay was between 21-40 days (36%). This long duration of hospitalization can be explained by the refractory to the treatment of the lesions owing to the diminished resistance of the body, hyperglycemia, prepared hormonal defense mechanisms and resistance of the organisms to antibiotic therapy.

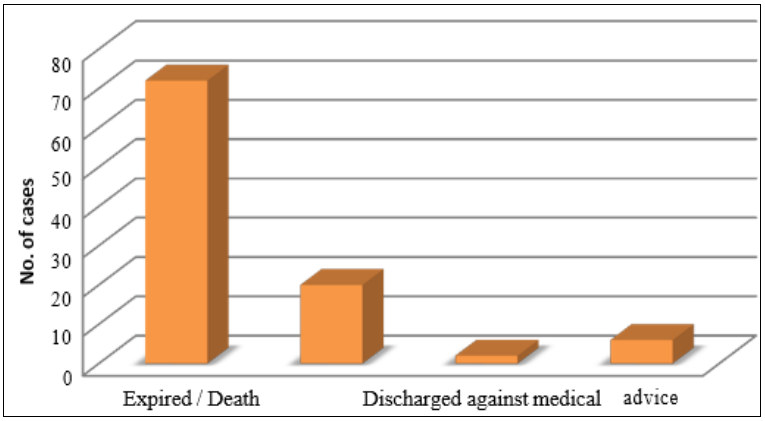


Graph 11: Duration of hospital stay

Table 12: Prognosis

Prognosis	No. of Patients	Percentage
Good	72	72
Satisfactory	20	20
Expired / Death	2	2
Discharged against medical advice	6	6

In this series 72 (72%) cases prognosis was good and in 20 (20%) cases it was satisfactory. 2 (2%) patients died of septicemia and 6 (6%) cases were discharged against medical advice.



Graph 12: Prognosis

Fig 1: Diabetic foot with unhealthy tissue

Fig 2: Diabetic foot with gangrenous patch

Fig 3: Diabetic foot with maggots

Fig 4: Diabetic foot dressing materials

Fig 5: Above knee amputation

Fig 6: Diabetic foot with celluties

Fig 7: Diabetic foot with gangrenous toes

Discussion

Hundred cases were studied from Jan 2020 to Jun 2021 at Trichy SRM Medical College and Hospital, TRICHY The analysis of this study as follows.

Table 13: Age

Age Group	Wheel, Locked and Root Series 1969118	Present Study
Youngest	32	31
Oldest	89	80

When compared with Wheel, Lock and Root series, there is not much HR difference in youngest and oldest age group.

Table 14: Sex wise distribution

Sex	Jennifer A. May field et. al., 119		Present Study	
	No. of Cases	Percentage	No. of Cases	Percentage
Male	32	53	78	78
Female	29	47	22	22

Like Jennifer A. May field *et al*., study, the Present study had more number of male patients 39 (78%) suffering from diabetic foot lesions than females 11 (22%). But the proportion between the two was far greater in this study.

The present study had ratio of Male: Female as 3.54: 1. The incidence is more f*'; among males probably as they are mostly working out door, which makes them more vulnerable for trauma and sequel.

Table 15: Mode of presentation (gangrene)

Cases	Mode of Presentation			
	Bell series I960120	Pennsylvania Hospital series	Diabetic research center (2005)	Present study
No. of Cases	946	614	1319	100
No. of Cases with Gangrene	236	274	64	24
Percentage	24.9	44.78	5	24

Incidence of gangrene in the present series is comparatively equal to that of Bell series of 1960.

Table 16: Site of lesions

Site of Lesion	Apelquist *et al*., [314]121	Reiber *et al*., [n=302]122	Present Study [100]
Toes	51	52	44
Dorsum of foot	14	11	64
Plantar metatarsal heads, Mid foot & Heel	9	18	36
Multiple ulcers	7	0	0
Whole fore foot	0	0	56

Out of 100 cases studied in this series, 22 cases (44%) presented as diabetic. ulcers. Out of these, 22 cases, the most common site of occurrence was on dorsum of foot 32% where as in Apelquist *et al*., and Reiber *et al*., study the common site was toes which was 51% and 52% respectively. Surprisingly toes (15%) were the least common site to be involved in the present study.

Table 17: History of trauma

	Jennifer. A., may field *et al*., 119		Present Study	
	No. of Cases	Percentage	No. of Cases	Percentage
Trauma	27	44	60	60
New onset of Ulcer without trauma	24	39	40	40
Other dermatological			0	
Abnormalities vascular	10	27		0
Etiology etc.,				

60 (60%) cases in this series had a history of trauma before the onset of the lesion. In Jannifer. A. May Field *et al*., there was no significant percentage of cases: with respect to history of trauma prior to occurrence of diabetic foot lesion.

Neuropathic lesions (Complications)

In the present study 26 (52%) cases were found to have neuropathy. The, majority of the patient had history of diabetes of more than 5 years. This shows that peripheral neuropathy is common in long standing diabetic patients.

Table 18: Comparison of incidence of neuropathy

	Root Series 1955	Bonkalo 1960	Grams 1969	Duncam 1969123	Pennsylvania 1969	Present Study
No. of Cases	3175	150	264	354	614	100
Neuropathy	1206	74	84	125	175	52
Percentage	37.99	44.33	31.81	35.31	28.5	52

Table 19: Culture and sensitivity comparision

	Percentage of patients			
	Gibbons *et al*. 124. ai.,	**Wheat *et al*., 125**	**Hughes *et al*., 126**	**Present Study**
Staph aureus	22	20	25	30
Streptococcus species	13	23	20	14
Pseudomonas species	3	4	0	18
E.Coli	7	5	3	10
Klebsiella	4	6	7	8
Proteus	11	9	11	6

In the present study the commonest organism cultured was *staphylococcus aureus* 15 (30%) which was similar to study conducted by Gibbons *et al*. and Wheat et. al., studies.

Treatment

In the present series, 12 cases were treated by slough excision and regular U dressing. 14 cases were treated by wound debridement 10 with SSG, 16 by disarticulation of single or multiple toes at the level of metatarsophalangeal joints. I & D and fasciotomy done in 6 and 10 eases respectively. Below knee amputation was M\H done in 4 cases and above knee amputation was done in 14 'cases.

Proper control of diabetes is very important in diabetic foot management fasting and post prandial blood sugar estimations were well under control.

Infection was treated with broad spectrum antibiotics. Patients were educated about care of the foot.

Table 20: Amputation

Amputation	**Collen's Series (1962)127**	**Osakakosainekin Hospital (2005)**	**Present Study**
Number of Cases	215	210	100
Number of Amputation	83	110	18
Percentage	38.6	52	18

The amputation rate is much lower 18% compared to collen's series 38.6% in 1962. This could be due to, better education of the patient, better glycemic control; proper case of foot, proper use of antibiotics, extensive debridement and regular ^J-dressing after amputation wound healed well. The patients were referred to H* rehabilitation center for properties.

Table 21: Lesion outcome (prognosis)

Lesion Outcome	**Apelquist *et al*., 12°**	**Reiber *et al*., 121**	**Present Study**
Re-epithelialization or Primary healing	63	81	66
Amputation at any level	24	14	321
Death	13	5	2

In the present series out of 100 cases studied 66% cases had good prognosis. One 2% patient died and 32% patient underwent amputation at various levels. Conservative treatment are more in both study.

Conclusion

This study consists of 100 cases of diabetic foot patients with emphasis on surgical management and its complications over a period of 18 months. After analysis of the data the following are the conclusions.

- The youngest patient in present study series of 100 patients studied was 31 years, and the oldest 80 years. The highest number of patients was seen in the age group of 61-70 years.
- The male to female ratio was approximately 3.54: 1. Surgical complications are more common in men due to their increased susceptibility to trauma, smoking, and alcoholism.
- Commonest presenting lesion was ulcers, followed by gangrene and cellulitis.
- Commonest site of lesion was dorsum of foot followed by fore foot and toes.
- Trivial trauma (prior to diabetic foot lesion) is the initiating factor in more than half of the cases.
- Duration of the diabetes varies from 4 months to 24 years.
- More than half of the patients had infection in addition to ischemia or neuropathy. This study indicates that all these three factors can be present in a patient with diabetic foot lesions.
- Minimum duration of stay in hospital was 10 days and maximum 150 days.
- Most common microorganisms grown from culture taken from the lesion was *staphylococcus aureus* followed by pseudomonas.
- Conservative treatment consists of control of diabetes with human actrapid/human mixtard/lente/Glargine insulin along with appropriate oral or iv antibiotics was effective in most of the cases.
- Wound debridement, slough excision, followed by dressing with povidone-iodine, metronidazole, collagenase, L-lysine, mupirocin, etc., dressings resulted in healing of ulcers.
- Split skin grafting, disarticulation, bellow knee amputation, and above knee amputation, were the other modes of treatment. Mortality rate in the present study was2%.

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