



Introduction

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Abstract

To understand diabetic foot problems (DFP) or to prevent it from developing in a diabetic, one must appreciate the important role played by the “diabetic triad” of neuropathy, vasculopathy and immunopathy. The type of clinical manifestation depends on the dominance played by one or more risk factors of this triad. DFP can present as cellulitis, abscess, osteomyelitis, septic arthritis, dry gangrene, wet gangrene, ulcer, Charcot joint disease or necrotising fasciitis. The DFP must be accurately diagnosed and is best classified using the King’s College Foot Classification. The strategy for managing DFP lies in its prevention. For this, all diabetics are encouraged to follow clinical guidelines developed for patients with diabetes. Annual foot screening recommended in these guidelines serves to detect early the “high risk foot” to prevent development of diabetic foot complications, thereby preventing lower limb amputations. When prevention fails and foot complications develop, such problems are best managed in secondary or tertiary institutions by the multi-disciplinary team approach, in combination with the implementation of an effective clinical pathway.

Keywords: Diabetic Foot Problems; “Diabetic Triad”; Neuropathy; Vasculopathy; Immunopathy; Clinical Presentation Modes; Accurate Diagnosis; Classification System; Prevention; Clinical Guidelines for Diabetics.

1. Pathogenesis

In order to prevent diabetics from developing diabetic foot problems (DFP) and to manage them effectively once they have developed, it is

important to understand the pathogenesis of DFP. One must recognise the important role played by the “diabetic triad”¹ consisting of three risk factors: neuropathy, vasculopathy (ischaemia) and immunopathy (infection) (Figs. 1 and 2). Not all three risk factors may contribute to the development of the DFP. It varies from individual to individual. In some patients one component dominates, e.g. dry gangrene due to ischaemia. In others a combination of two factors are responsible, e.g. wet gangrene due to ischaemia



Fig. 1. Triple jeopardy: neuropathy, vasculopathy and immunopathy.

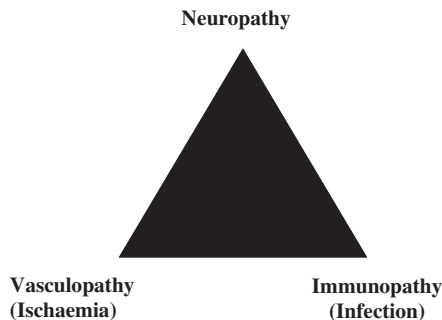


Fig. 2. “Diabetic triad” of neuropathy, vasculopathy and immunopathy.

and infection. In yet others, all three factors are contributory — neuropathy, ischaemia and infection, e.g. abscess and gangrene of toes in an insensate foot.

2. Neuropathy

Neuropathy is at the top of the triad. It is usually the starting point of most DFP. Peripheral neuropathy manifests as motor, sensory and autonomic neuropathy. Motor neuropathy manifests itself as weakness of the foot or clawing of the toes. Sensory neuropathy presents as “glove and stocking” sensory disturbance in the feet either hyperaesthesia or pins and needles, hypoaesthesia or anaesthesia. Autonomic neuropathy presents as dryness of the skin. The incidence of sensory neuropathy in DFP is 42.1% in our local study.² Abbot *et al.*³ showed that 90% of diabetics with foot ulcers have peripheral neuropathy.

3. Vasculopathy

DFP presents as a peripheral vascular disease (PVD) rather than as a microangiopathy. The PVD or atherosclerosis involves both the large- and medium-sized vessels, e.g. aorta, femoral arteries and the medium-sized vessels like popliteal, dorsalis pedis, and posterior tibial. Besides PVD in diabetics, microangiopathy may also occur in some cases involving the terminal arterioles due to thickening of the basement membrane of the endothelium. Fourteen percent of diabetics with foot ulcers have peripheral arterial disease.³ Nather *et al.*² in a study of 202 patients with DFP found that 54.2% of patients had an ankle brachial index of < 0.8 (indicating ischaemia).

4. Immunopathy

Immunopathy is a significant cause of the various manifestations of the DFP. Diabetics have inherent susceptibility to infection due to defects in

leukocyte function leading to defective phagocytosis, neutrophil dysfunction and deficient white cell chemotaxis and adherence. Bacteria that are found in DFP are predominantly Gram-positive Cocci, e.g. *Staphylococcus aureus*, Group B *Streptococcus pyogenes*, Group A *Streptococcus agalactiae* and methicillin-resistant *Staphylococcus aureus* (usually found in patients who have been previously hospitalised). Due to immunopathy, the patients are also susceptible to infection by Gram-negative rods such as *Proteus vulgaris*, *Escherichia coli* and *Pseudomonas aeruginosa* (Fig. 3) as well as by anaerobes, e.g. *Bacteroides fragilis* and *Peptostreptococcus* — microbes which are not commonly found in infections affecting normal healthy adults.

Mild infections tend to be monomicrobial and are mainly due to Gram-positive Cocci. Severe infections tend to be polymicrobial.⁴ Gram-positive Cocci still dominate.

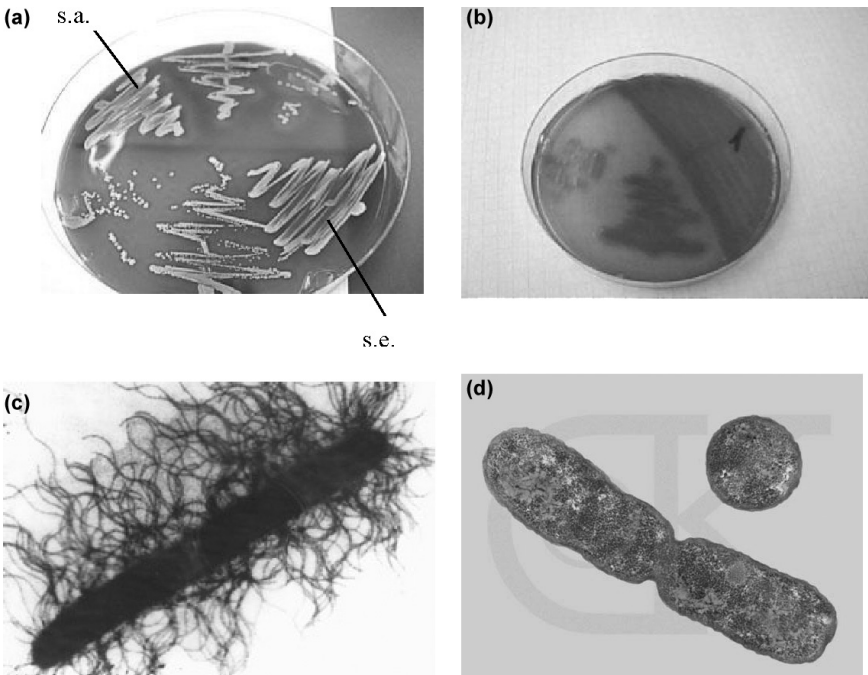


Fig. 3. (a) *Staphylococcus aureus* (s.a.) and *Staphylococcus epidermidis* (s.e.). (b) *Pseudomonas aeruginosa*. (c) *Proteus vulgaris*. (d) *Escherichia coli*.

Nather *et al.*² found infections to be present in 122 patients (60.4%) in a cohort of 202 patients with DFP — 63 patients (31.2%) with monomicrobial infections and 59 patients (29.2%) with polymicrobial infections. When both monomicrobial and polymicrobial infections were considered together as one entity, the most common pathogens in this cohort were *Staphylococcus aureus* (22.3%), *Pseudomonas aeruginosa* (15.8%) and *Bacteroides fragilis* (9.9%).

5. Modes of Clinical Presentation

The type of foot problem presented by a diabetic depends on the dominant role contributed by one, two or all three components of the “diabetic triad”.

Sensory neuropathy is very often the cause for a diabetic problem to occur. Failure to appreciate pain and the occurrence of trauma at home — fall in the bathroom, knock of the toe against side of bed or the leg of a chair at home is usually responsible for starting the DFP. Very often, this remains unrecognised. As a factor, it seldom occurs alone. Immunopathy or vasculopathy or both in combination with sensory neuropathy may be responsible for the development of the foot lesion.

Vasculopathy can lead to PVD causing dry gangrene, intermittent claudication and rest pain. If superimposed by immunopathy, wet gangrene occurs. Microangiopathy leads to terminal gangrene of toes even when both foot pulses are strongly palpable in that patient.

Immunopathy can present as cellulitis, abscess, osteomyelitis, septic arthritis or necrotising fasciitis.

The type of DFP developed as a complication of diabetes includes the following:

- cellulitis (Fig. 4)
- abscess — superficial
— deep (Fig. 5)
- osteomyelitis
- septic arthritis
- gangrene — dry (Fig. 6)
— wet (Fig. 7)



Fig. 4. Cellulitis.



Fig. 5. Abscess dorsum foot.



Fig. 6. Dry gangrene big toe.



Fig. 7. Wet gangrene second and third toe.



Fig. 8. Ulcer heel.

- ulcer (Fig. 8)
- Charcot joint disease (Fig. 9)
- necrotising fasciitis (Fig. 10).

6. Choice of Classification for DFP

In assessing a diabetic foot it is important to classify the DFP. The King's College Foot Classification⁵ is chosen as it is simple and is also a practical classification to use, with a specific management recommended for each



Fig. 9. Charcot joint disease.



Fig. 10. Necrotising fasciitis left leg with classical haemorrhagic blisters.

stage classified. This classification is now universally recognised and has superseded Wagner's Classification⁶ and University of Texas Classification.⁷ The details of King's Classification are described in Chapter 9: Classification Systems together with Wagner's and Texas Classifications.

7. Strategy for Managing DFP

The strategy for managing DFP lies in its prevention. The ultimate aim of all programmes for managing DFP is in the prevention of such foot

complications.¹ Indeed, the early detection of risk factors for DFP — the triad of neuropathy, vasculopathy and immunopathy are key components in the overall management of diabetic foot disorders and amputation prevention programmes.¹ It is also well recognised that foot ulceration is one of the major risk factors of amputation.¹

Several guidelines for all diabetics have been developed to help diabetics from developing foot complication. In Singapore, all diabetics are advised to comply to the following national guidelines which include:

- dietary restriction
- exercise regime
- HbA1c levels quarterly
- capillary blood glucose monitoring regularly
- creatinine level yearly
- foot screening yearly
- renal screening yearly
- eye screening yearly

according to the Ministry of Health Guidelines for Diabetes 2006.⁸

Annual foot screening will allow health care professionals to detect the foot at “high risk” early so that appropriate measures can be taken to prevent development of diabetic foot complications and thereby prevent lower limb amputations from being performed.

When preventive measures fail and diabetic foot lesions develop, such foot complications are best managed in secondary or tertiary health care institutions by the multi-disciplinary team approach⁹ coupled with the implementation of an effective clinical pathway.¹⁰

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