Chapter

Diagnosis, Treatment, Multidisciplinary Collaborative Therapy and Prevention of Diabetic Foot

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Abstract

Diabetic foot (DF) is one of the most common complications of diabetes. Diabetic foot is one of the main causes of disability and death of diabetic patients, and it is also a major public health problem that causes a heavy burden on society. Diabetic foot involves a variety of factors including peripheral nerve tissue lesions, ischemic lesions, and reduced body immunity. With the development of medical standards, clinical knowledge and treatment of diabetic foot are constantly improving. Early diagnosis and intervention is the key to reducing the incidence of diabetic foot and improving the cure rate. This chapter will briefly introduce the diagnosis, the treatment, the multidisciplinary collaborative therapy and prevention of diabetic foot.

Keywords: diabetic foot, multidisciplinary collaborative therapy, prevention

1. Introduction

Diabetes Mellitus is a chronic non-communicable epidemic that has become the most important in the world. Diabetic foot (DF) is one of the most common complications of diabetes. The global prevalence of diabetic foot is 6.3%, male are higher than female, and type 2 diabetes is higher than type 1 diabetes. The prevalence of diabetic foot varies greatly from country to country, varying from 1.5 to 16.6% [1]. DF is one of the primary causes of disability and death of diabetic patients, and it is also a major public health problem that causes a heavy burden on society.

It is estimated that there is one amputation of diabetic patients every 20 seconds in the world [2]. According to the statistics of the World Health Organization, about 50% of all non-traumatic amputations are due to diabetic foot amputation [3]. The annual mortality rate of patients with diabetic foot is as high as 11%, and the mortality rate of amputated patients is as high as 22% [4]; many studies have shown that diabetic foot costs are huge, accounting for about one-third of the entire diabetes medical cost. In 2017, the global medical cost of diabetes was as high as 727 billion US dollars, of which China was 110 billion US dollars [5]. In developed countries, diabetic foot occupies 12–15% of diabetes medical and health resources, while in developing countries, up to 40% [6]. One third of the medical cost of diabetes in the United States is used for diabetic foot patients [7].

Diabetic foot is the most common cause of hospitalization, with the characteristics of long hospital time, difficult treatment and high medical cost. According to recent big data from the United States, compared with ambulatory diabetic outpatients, diabetic foot patients are 3.4 times more hospitalized or emergency patients, 2.1 times more referrals to specialists, and 1.9 times more annual visits. Physicians spend more time on diagnosis and treatment; patients with diabetic foot infection (DFI) are directly referred to the emergency department or hospitalized by 6.7 times.

Diabetic foot is one of the main causes of disability and death of diabetic patients, and it is also a major public health problem that causes a heavy burden on society.

Diabetic foot involves a variety of factors including peripheral nerve tissue lesions, ischemic lesions, and reduced body immunity. It can be seen that the diagnosis and treatment of diabetic foot need to involve multiple disciplines and fields. With the development of medical standards, clinical knowledge and treatment of diabetic foot are constantly improving. Early diagnosis and intervention is the key to reducing the incidence of diabetic foot and improving the cure rate.

2. Definition and classification of diabetic foot

2.1 The definition of diabetic foot

The causes of diabetic foot are multifactorial. Diabetic peripheral vascular disease, peripheral neuropathy and infection are the basic causes of diabetic foot, which can exist alone or in combination with other factors.

Diabetic foot is the destruction of the skin and deep tissues of the ankle joint of diabetic patients. It is often complicated by infection and/or arterial occlusive disease of different degrees in the lower extremities. In severe cases, muscle and bone tissues are involved. The World Health Organization has a clear definition of diabetic foot, foot infection, ulcers and deep tissue damage caused by abnormal nerves in the lower extremities and varying degrees of lesions in the surrounding blood vessels.

The following people are prone to diabetic foot: old, living alone, male, with a diabetes course of more than 10 years, a history of paraplegia, uncontrolled high blood sugar, and little knowledge about diabetes, combined with foot mold, deformity, calluses, etc.

2.2 Diabetic foot classification

For a DF patient, a comprehensive systemic condition assessment and a foot assessment are necessary. The foot assessment includes the blood supply of the foot, the size and depth of the ulcer, the condition and severity of ulcer infection. Diabetic foot ulcer classification assessment: cause classification, nature classification, then grading and staging, and finally select the appropriate treatment method according to grading and staging.

At present, the common clinical grading methods of diabetic feet include Wagner Ulcer Classification and University of Texas Diabetic Wound Classification. Wagner Ulcer Classification method is currently the most classic grading method. It is divided into 6 levels according to the depth of skin damage and the presence or absence of gangrene. The advantage of this grading system is that it is easy to use in clinical applications. It can be graded without auxiliary examination tools, and can also reflect the severity of ulcers and gangrene. The disadvantage of this system is that it does not reflect the etiology of the foot and lacks reproducibility

and specificity when grading ulcers. In addition, superficial cases with or without ischemia cannot be correctly graded, and ischemia is only mentioned in grades 4 and 5.

2.2.1 The Wagner classification of diabetes

Grade 0, No ulcers in a high-risk foot.
Grade 1: Superficial Diabetic Ulcer.
Grade 2: Ulcer extension Involves ligament, tendon, joint capsule or fascia. No abscess or Osteomyelitis.
Grade 3: Deep ulcer with abscess or Osteomyelitis.
Grade 4: Gangrene to portion of forefoot.
Grade 5: Extensive gangrene of foot [8].

2.2.2 University of Texas Diabetic Wound Classification

Stages.
Stage A: No infection or ischemia.
Stage B: Infection present.
Stage C: Ischemia present.
Stage D: Infection and ischemia present.
Grading.
Grade 0: Epithelialized wound.
Grade 1: Superficial wound.
Grade 2: Wound penetrates to tendon or capsule.
Grade 3: Wound penetrates to bone or joint [9].

3. Pathogenesis of diabetic foot

3.1 Neuropathy

Peripheral neuropathy is one of the important causes of diabetic foot. Relevant research data shows that patients with diabetes over 25 years have a 50% chance of developing peripheral neuropathy, and diabetic foot patients have the highest proportion of with neuropathy [10]. Studies have confirmed that the occurrence of neuroarthropathy is related to autonomic neuropathy; motor neuropathy can lead to metatarsal deformation in diabetic patients, foot muscle atrophy, and increased plantar pressure. In addition, neuropathy can cause diabetic patients to lose their ability to feel external stimuli and injuries, which is also a high-risk factor in the formation of skin injuries such as burns and abrasions.

3.2 Vascular disease

Vascular disease is another important cause of diabetic foot. Long-term hyperglycemia in diabetic patients can cause lesions such as vascular intima damage and vascular occlusion. When the vascular lesions of the lower extremities occur in diabetic patients, they can lead to ischemia and hypoxia in the lower extremities, especially the feet, so that when they urgently need to increase blood circulation, the blood flow cannot increase accordingly, ulcers or even gangrene will occur. In addition, microcirculation disorders caused by vascular lesions can also lead to neuron dystrophy and aggravate nerve function damage, thereby increasing the incidence of ulcers.

3.3 Infection

Leukocyte dysfunction caused by dysglycemia in diabetic patients can lead to decreased immunity of the patient and prone to infection. Infection is also an important inducer of diabetic foot gangrene, and severe cases may even cause sepsis and be life-threatening. Studies have shown that Gram-positive cocci such as *Staphylococcus aureus* and *Enterococcus faecalis* are the main infections of mild infections, and Gram-negative bacillus infections of Proteus and *Escherichia coli* are the main infections of moderate and severe infections.

3.4 Others

Foot deformity, smoking, obesity, visual impairment, alcoholism, and lack of knowledge about diabetic foot are all closely related to the occurrence of diabetic foot.

4. Treatment of diabetic foot

4.1 Medical treatment of diabetic foot disease

Comprehensive medical treatment is the basis of diabetic foot treatment, including strict control of blood sugar and blood pressure, lipid regulation, anti-infection, improvement of microcirculation, correction of hypoproteinemia, elimination of edema and various adverse factors affecting prognosis, etc.

4.1.1 Basic treatment

The basic treatments of diabetic foot mainly include blood sugar control, improve systemic nutrition, strengthen anti-infective treatment, control blood pressure, blood lipids, improve local circulation and blood oxygen.

4.1.2 Blood sugar control

Diabetes patients due to long-term high blood sugar, glucose and nucleic acid and other macromolecular substances combine to cause damage or abnormal function of vascular endothelial cells, and then the blood vessel coagulation function is disordered, causing thrombosis and microcirculation disorders, and ultimately leading to extremities, especially feet ischemia, hypoxia, metabolic disorders, and even ulcer necrosis [11].

Several studies have confirmed that good blood sugar control can effectively reduce the incidence of microvascular disease. Intensive blood glucose management with the A1C goal of <7% is associated with a reduction of microvascular and neuropathic complications of diabetes, and also can lead to a 25% risk reduction of amputation compared to less intensive glycemic management [12]. One systematic review of 19,234 patients also concluded that enhanced blood glucose control can significantly reduce the risk of amputation in patients with DF.

4.1.3 Blood pressure and blood lipid control

Hypertension is the main risk factor for lower extremity arterial disease. For diabetic patients with hypertension, early control of blood pressure can

significantly reduce the occurrence of macrovascular disease. Angiotensin converting enzyme inhibitors are recommended, but other antihypertensive drugs can also be used. Diabetes patients with lower extremity arterial disease are often accompanied by dyslipidemia [13]. On the basis of diet control and exercise lipid-lowering, combined with statin lipid-lowering treatment can help the healing of foot ulcers [14].

4.1.4 Infection control

Diabetic foot infection (DFI) is one of the most important causes of patients' deterioration, amputation and death. However, after proper treatment, most patients can be cured. Therefore, active treatment of DFI is beneficial to patients, society, and economy. Multi-drug resistant bacterial infections often indicate a poor prognosis [15].

Once DFI is established, the severity of DFI must be graded. The classification tool recommends the IWGDF/IDSA infection grading system. Antibiotic treatment of diabetic foot infections cannot replace thorough wound debridement treatment. Thorough and adequate debridement and drainage is the basis of effective anti-infective treatment [16].

Treatment principles: thorough and effective debridement is directly related to wound healing. For different types of wounds, the timing debridement should be accurately grasped; physical debridement is the basis of wound treatment. When physical debridement is not suitable, autolytic debridement, Enzymatic debridement, traditional dressing debridement and maggot debridement and other types of debridement should be considered. Decompression treatment of diabetic foot ulcers should adhere to the principle of individualization and continuity, combined with the condition of infection and lower limb ischemia, patients' wishes and ulcers types.

A prospective study of diabetic foot ulcer patients with co-infection showed that in the first year after infection, 15.1% of patients died and 17.4% of patients had at least part of their lower limbs amputated [17]. Studies have found that 49% of diabetic foot ulcer infections are mixed infections. The main pathogens are *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and Enterobacteriaceae [18]. In addition to timely and reasonable surgical treatment of wounds, it is necessary to select antibiotics against common pathogens and early anti-infective treatment according to experience before obtaining the results of pathogenic examinations, and adjust sensitive antibiotics according to the results of pathogenic examinations. In order to improve the positive rate of culture, it is recommended to carry out pathogenic culture or histological examination of deep tissue scrapes before antibiotic treatment, and avoids the use of swab specimens [19]. The use of antibiotics is not recommended for ulcers without signs of infection, the initial antibiotic treatment plan for foot ulcers with infection is an empirical choice, but requires the cultivation of ulcer tissue microorganisms before the application of antibiotics. If clinical treatment is effective, although microbial culture plus drug sensitivity tests show insensitivity, the original treatment plan is suggested. If the patient is not effective with the empirical plan or the infection progresses, antibiotics need to be replaced according to the culture results; mild infection (skin or subcutaneous tissue) takes 1–2 weeks of treatment; moderate to severe infection 2–3 weeks.

For patients with diabetic foot combined with osteomyelitis, the diagnostic methods include clinical examination, such as probe and bone test (probe to bone test): the method has a sensitivity of 66%, a specificity of 85%, and a positive predictive value 89%. X-ray radiograph is little significance for the diagnosis of osteomyelitis, and repeated radiographs every 2–4 weeks can find bone destruction

and increase the detection rate of osteomyelitis, MRI is more sensitive to the diagnosis of osteomyelitis 95%, but less sensitive to osteomyelitis with smaller bones. Bone scan and CT are of little significance for the diagnosis of osteomyelitis, bone biopsy is the gold standard for diagnosis, and histological culture results can guide antibiotic selection.

Treatment methods include: anti-infection alone, anti-infection combined with minor surgery: drainage of pus, removal of infected bone, etc.; amputation (toe) combined with antibiotic treatment. Compared with surgical treatment, antibiotics alone are cheaper to treat osteomyelitis, but about 17% are ineffective. Gram-positive cocci infections are the most common bacteria. Broad-spectrum antibiotics are usually selected, and the course of treatment is 6 weeks to 6 months.

4.2 Local wound management of diabetic foot ulcers

4.2.1 Specialized nursing

Local treatment of the wound surface is essential for the healing of diabetic foot ulcers. If treated properly, it can accelerate the healing of ulcers. The "wet healing theory" and "wound bed preparation theory" are innovative developments in chronic wound specialty care in recent years. Wet healing has the following advantages: regulating the oxygen tension of the wound surface and promoting the formation of capillaries, retaining the content contained in the wound exudate tissue proteolytic enzyme is conducive to the dissolution of necrotic tissue and fibrin, promotes the release of various growth factors, maintains the constant temperature of the wound, facilitates the growth of the tissue, without the formation of scabs, and avoids the mechanical damage of the new granulation tissue, protects the nerve endings of the wound, and reduce pain. The core content of "wound bed preparation" is that the wound surface can be divided into four stages of black, yellow, red, and pink according to the color of the wound base. The black stage and the yellow stage are suggested to use of debridement and the use of antibacterial dressings to remove necrosis, and bacterial load. In the red period, treatment with growth factors such as basic fibroblast growth factor, hydrogel dressing, alginate dressing, etc. can promote the proliferation of granulation tissue of the wound surface and quickly fill the wound defect. The powder phase is mainly to protect the wound surface and promote epithelialization, and perform skin grafting when necessary.

4.2.2 Debridement technology

In terms of debridement technology, in addition to traditional surgical debridement, some new debridement techniques have emerged. Such as autolytic debridement, chemical (protein solubilizing enzyme) debridement, mechanical debridement (including ultrasonic debridement waterjet and wound negative pressure treatment, etc.) and biological (maggot) debridement, etc.. These techniques have their own advantages and disadvantages, so clinicians should master their adaptations and contraindications, choose the most appropriate debridement method for different ulcer conditions, and ensure the maximum therapeutic effect. In addition, the above method is only applicable to neurological ulcers or neurovascular ischemic ulcers. For ischemic ulcers, if the affected limb ischemia is severe, excessive local debridement should be avoided. Vasodilator drugs, intraluminal balloon dilation, stent placement, or vascular bypass surgery and autologous stem cell transplantation can be used to improve limb blood supply. When the blood supply of the affected limb improves, local debridement treatment can be performed to remove excessive keratosis, infected and inactivated tissues.

4.2.3 Dressing

The application of dressings can help promote the healing of ulcers, and the "wound bed preparation theory" can guide the choice of dressings. It is clinically recommended to use hydrogel dressing in the black period to fully soften dry necrotic tissue; the yellow period mainly removes bacterial load, absorbs excessive wound exudate, promotes the growth of granulation, transitions to the red period, alginate dressing, hydraulic adhesive dressings and antimicrobial dressings are suitable choices. The red stage and powder stage are the period of granulation and epithelial growth, and the leakage is reduced, ultra-thin hydrocolloid dressings or biological dressings containing growth factors can be choose.

4.2.4 Growth factors

The wound repair process involves the role of many cytokines, including epidermal growth factor, vascular endothelial growth factor, transforming growth factor -β, fibroblast growth factor and erythropoietin, etc. These cytokines have a promoting effect on the proliferation of fibroblasts and capillaries, the migration, granulation tissue growth and wound epithelialization, which ultimately promotes wound healing in diabetic patients [20]. In terms of promoting the growth of ulcer granulation, there are currently a variety of synthetic growth factors such as platelet-derived growth factor, basic fibroblast growth factor, human epidermal growth factor and transforming growth factor [21, 22]. In addition, APG shows a more obvious advantage in the treatment of refractory skin ulcer sinus tract closure. Survival analysis of sinus tract closure time suggests that the closure rate of APG treatment on the sinus tract is significantly better than standard treatment, suggesting that APG is used to treat refractory diabetic skin. Effective, safe and feasible in ulcers.

4.3 Surgical treatment of diabetic foot disease

For those with severe ischemia and poor medical treatment, surgical methods should be used. The ultimate goal is to reduce the pain caused by ischemia, promote ulcer healing, avoid amputation due to limb necrosis, and improve the quality of life. The surgical treatment of diabetic foot mainly includes percutaneous endovascular interventional therapy, surgical vascular bypass reconstruction, stem cell transplantation and amputation.

For patients who are ineffective for medical treatment and are not suitable for minimally invasive treatment of the vascular cavity, surgical vascular reconstruction surgery is recommended. Surgical treatment includes arterial endarterectomy, artificial blood vessel and/or autovascular bypass. Surgical treatment requires that the patient can tolerate anesthesia and surgical shock.

Percutaneous endovascular interventional treatment includes traditional percutaneous balloon dilatation (PTA), stent implantation, percutaneous intimal circumcision, and Pedal-Plantar Loop technology for small vessel disease of the foot. In recent years, with the invention of new types of balloons and stents (drug-coated balloons and stents, etc.), especially the application of a series of products with small diameters and long balloons dedicated to lower extremity arteries, the long-segment occlusion lesions and infra-knee arteries significantly improved clinical efficacy. For diabetic inferior knee arterial disease, the technical success rate of PTA alone is 86%, the 1-year patency rate is 53–56%, and the limb salvage rate is 81–85%. The 1-year patency rate is 54%, and the limb salvage rate is 97.1%, but there is a risk of contrast-related nephropathy, especially in patients with potential or

renal insufficiency, the incidence is higher and the prognosis is poor. Therefore, for patients with ischemic ulcers, when clinically considering the use of percutaneous intravascular interventional therapy, adequate hydration should be performed and the changes in renal function of the patients should be closely monitored.

If autologous vascular bypass is performed, a good saphenous vein is also required. By-pass surgery using autologous blood vessels, the 5-year patency rate was 63%, and the salvage rate was 78%. For the treatment of sub-knee occlusion with saphenous vein bypass, the patency rates at 1 and 3 years were 63 and 50%, and the salvage rates were 85 and 79%. When the foot disease further develops and leads to irreversible ischemic necrosis of the limb, or necrosis of the affected limb with serious infection that cannot be controlled, directly threatens the patient's life, or the long-term spasm of the distal small artery due to severe peripheral neuritis causes the limb to become distant. For patients with end-stage ischemic necrosis, amputation is not only a treatment method, but more importantly, it can save the patient's life. For diabetic foot amputation, the amputation plane should be reduced as much as possible on the premise of ensuring the amputation effect, and arteriography should be performed before the amputation to determine the amputation plane.

4.4 Multidisciplinary collaborative therapy

The systematic review shows that multidisciplinary team collaboration therapy can focus on the advantages of various professions, which has a positive impact on shortening wound healing time, reducing amputation rate and reducing the severity of amputation [23]. The treatment of diabetic foot requires clinical multidisciplinary collaboration. The diabetic specialist first evaluates the patient's systemic condition to minimize the occurrence of cardiovascular complications; at the same time evaluates vascular conditions and creates percutaneous vascular intraluminal intervention treatment or surgical treatment conditions, discuss operative methods with vascular surgery and endovascular interventional physicians, orthopedic physicians, make rescue plans for intraoperative and postoperative cardiovascular events, and follow-up and drug adjustment after successful surgery. Only in this way can the blood circulation reconstruction of diabetic foot patients be improved to the greatest extent, and amputation and death rates can be reduced. Early and timely multi-disciplinary collaborative treatment is also recommended by the domestic 2017 version of the guidelines.

A multi-disciplinary team of diabetic foot medical care professionals can effectively reduce the rate of diabetic amputation and medical expenses, and improve the quality of life of patients. In the recently reported 240,000 rural areas of England, after the establishment of a multidisciplinary team of diabetic foot led by vascular surgery experts, the amputation rate of diabetic lower limbs decreased from 412 per 100,000 to 15–44 per 100,000 [24]. The changes in medical services are reflected in: increasing the community's awareness and clinical path to this multidisciplinary collaborative podiatry team service, as far as possible, patients are admitted to specialty wards, a rapid referral channel, an operation room in the outpatient department for debridement, small amputation; a podiatrist, orthopedics and vascular surgery joint outpatient clinic; the hospital's senior podiatrist and community podiatrist have a network of links to pay attention to diabetic patients. For patients who need to strengthen outpatient follow-up, implement weekly or 2 weeks, a joint outpatient clinic; hospital specialists and nurses follow up the patients closely to achieve clinical follow-up at the patients' homes. The French medical management department requires that patients with diabetic foot must be referred to a hospital with a diabetic foot care team within 48 hours.

4.5 Stem cell transplantation for diabetic foot disease

Despite the rapid development of endovascular interventional techniques and surgical techniques, there are still some patients with ischemic foot disease can't receive interventional or surgical treatment. This part of patients is called "no Treatment Options for Patients. Recent clinical trials on autologous stem cell transplantation for lower limb ischemia have achieved satisfactory results. Tateishi-Yuyama et al. [25]. reported for the first time that bone marrow stem cell transplantation was used to treat patients with peripheral vascular disease, local autologous bone marrow mesenchymal stem cells were sprayed locally on chronic ulcers with a duration of more than 1 year. The wounds began to close after 2–4 weeks, and the wound healing rate was proportional to the number of stem cells; a 3-year follow-up of patients with autologous bone marrow mononuclear stem cell transplantation for the treatment of arterial ischemic diseases of the lower extremities showed that this treatment can improve the ischemia of the lower extremities for a long time and prolong the survival time of the affected limbs. Lu et al. also confirmed that bone marrow mononuclear stem cells and bone marrow mesenchymal stem cells can promote ulcer healing, prolong the claudication distance, increase ankle brachial index and percutaneous oxygen partial pressure in patients with diabetic foot, however, the effect of latter is better than the former. In addition, the combined application of stem cell transplantation and interventional therapy can make up for their respective shortcomings, and benefit more than a single method. Therefore, for patients with "no treatment options", consider referral to a qualified medical unit for autologous stem cell transplantation treatment. Although this treatment method is still under exploration and research, it is still its hope for future treatment.

5. Follow-up of diabetic foot

Peripheral neuropathy, lower extremity arterial disease (LEAD), and foot deformities are the main reasons for the increased risk of DFU. Age, gender, education, economic conditions, lifestyle habits and other complications or complications of diabetes are also important factors. Fully understanding these factors is very important for the risk assessment of diabetic foot and taking corresponding preventive measures.

The patient's quality of life is low, mental and psychological pressure is high, and the medical cost burden is heavy. Therefore, early evaluation to prevent foot ulcers and timely cure of ulcers to prevent recurrence, thereby avoiding amputations or large amputations above the ankle joint, is the focus of DF tertiary prevention.

It is generally believed that the preventive measures against DF should be divided into three levels. Primary prevention is to identify and avoid the risk factors that lead to DF as early as possible to prevent its occurrence; secondary prevention is to identify DF as early as possible and prevent its progress; tertiary prevention is to ensure appropriate treatment of DF.

5.1 Periodic inspections for DF high-risk factors

The main risk factors for DF include diabetic peripheral neuropathy, foot deformity, peripheral vascular disease, foot ulcer history, foot amputation or leg amputation history. According to the recommendations of the International Diabetes Foot Working Group (IWGDF), for patients with diabetes without

high-risk factors, a foot examination should be performed by a specialist at least once a year. For patients with high-risk factors, more frequent inspections should be conducted according to the category of high-risk factors, in order to detect these high-risk factors and their progress as soon as possible, and provide patients with appropriate measures to prevent foot ulcers [26].

5.2 Health education

Systematic diabetic foot related knowledge education can reduce the incidence of DFU, reduce the recurrence rate of DFU and improve the survival rate of footless ulcer events, reduce the amputation rate of DFU, reduce medical expenses and improve the quality of life of patients [27, 28]. Diabetic foot specialist medical staff educates patients and their families on foot protection knowledge and nursing, and helps them transform into effective actions [29]. Although there are few clinical studies that specifically assess whether health education can prevent DFU, and the level of evidence is low [30], these health education measures can enable patients to detect early lesions of DFU, strengthen self-behavior management, and keep feet clean which are important means to prevent ulcer occurrence and recurrence [31].

Predictors of DF amputation or re-amputation include adult males, long-term diabetes, wound infections, diabetic neuropathy, and smoking history [32]. DF occurs mostly in manual workers, patients are generally less educated, lack knowledge of diabetes prevention, lack of awareness of the severity of its complications, and pay insufficient attention to early blood glucose control and DF prevention. Therefore, we must pay attention to the health education of diabetic patients, so that they have a full understanding of the development and outcome of the disease, so as to actively cooperate with prevention, such as actively quitting smoking, controlling blood sugar, doing daily foot inspections, and doing foot protection., Foot care, pay attention to toenail trimming and comfortable footwear, etc., in order to detect and avoid the risk factors of DF as early as possible, to prevent the formation of ulcers, infections and further development.

5.3 Local load reduction measures

Qualified DF protective shoes can significantly reduce the incidence of foot ulcers. The custom-made DF protective shoes generally have the following functions: protect the sense of loss from external damage; adapt to the deformity of the foot to reduce pain and prevent the increase of the deformity of the foot; reduce excessive local pressure, so that the pressure is evenly distributed; reduce shear force in vertical and horizontal direction [33]. Multiple studies have shown that wearing foot protection shoes can effectively reduce plantar pressure by about 30%. Compared with wearing ordinary shoes, the risk of foot ulcer recurrence in DF patients is reduced by 46.1–70.2%. For patients with high-risk feet with hammer-toe diabetes who are not ideal for the use of conservative measures such as protective shoes, distal flexor tendon amputation can prevent the formation of tip toe ulcers, and its cost performance and risk-benefit ratio are encouraging [34].

For diabetic patients with risk factors for podiatry, early completion of diabetes peripheral neuropathy (DPN), vascular disease and podiatry screening, early detection and management of these high-risk patients are needed. Non-diabetic foot medical staff should refer to the diabetic foot specialist or consult with the specialist in a timely manner for patients with the following conditions: sharp changes in skin color, increased local pain and inflammation such as redness, new ulcers, original There are superficial ulcers that deteriorate and involve soft tissue and/or bone tissue, disseminated cellulitis, signs of systemic infection,

osteomyelitis, etc. Timely referral or consultation can help reduce the amputation rate and reduce medical costs, and timely intervention of the surgeon can help reduce the diabetic amputation rate and amputation plane.

Therefore, it is currently emphasized that for patients with diabetes, screening of lower extremity arterial diseases should be strengthened to achieve early diagnosis and early treatment. For patients with moderate to severe lower extremity arterial disease and complete foot skin, it is recommended to guide the patient to exercise rehabilitation exercise for at least 3–6 months, but for patients with foot skin ulcers, it is recommended to brake and avoid exercise rehabilitation At the same time, it is recommended to use low-dose aspirin, statin lipid-lowering drugs, angiotensin-converting enzyme inhibitors, vasodilator drugs and anticoagulant drugs, which can reduce the occurrence of ulcers and improve patients' lower limb motor function.

Acknowledgements

This work was financially supported by "Graduate education innovation program project of Guangdong province" (No. 2020XLLT10) and "Twenty-one teaching reform projects of Jinan University" (No. JG2019044). The funding body supported the team to design the study and collection, analysis, and interpretation of data and write the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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