Introduction

A seldom known fact: a major lower limb amputation due to complications from diabetes occurs once every 30 seconds worldwide. In Singapore, it is estimated that about 1000 major lower limb amputations a year or approximately 3 per day take place. These sobering numbers reflect the grim outcomes that diabetics with Peripheral Arterial Disease (PAD) face if they are not well managed. PAD is the narrowing or blockage of the lower limb arteries that results in diminished blood flow to the legs. Once limb loss has occurred, patients find a significant decrease in their quality of life due to the loss of mobility. As a result, these patients often find it very difficult to keep their jobs and become very depressed. Many spend their days either in bed or are wheelchair bound, making them prone to pneumonia and pressure sores. There is also significant physical, emotional and financial strain on family members and caregivers as patients require constant support, nursing and medical care. Therefore, every effort must be made to preserve the limbs of diabetics with PVD, thus saving their lives.
Presentation and Disease Progression

PAD of the lower limbs results from narrowing (stenoses) or complete blockage (occlusions) of the arteries in the lower limbs. These arteries are responsible for carrying oxygen and nutrient rich blood to the muscles and tissues of the lower limbs. Aside from diabetes, other risk factors include chronic smoking, hypertension and end-stage renal failure. In Singapore and Asia, the most significant of these risk factors remains diabetes. PAD is especially prevalent in diabetic patients who have poor or suboptimal blood glucose control. Multiple studies have shown a correlation between poor blood glucose (elevated HBA1c) level control and the development of PVD. This is further aggravated if patients also have poorly controlled blood cholesterol levels or continue to smoke cigarettes.

Patients with PAD are classified into 2 broad groups according to symptoms and signs.

1) Intermittent Claudication

These patients have severe cramping pain of the affected segment of the lower limb (i.e. thigh, calf or foot) that develops on walking or exercise. This severe cramping pain sets in usually after a repeated, fixed distance of walking or duration of exercise and is relieved by simply standing still (not sitting down). Patients may also have absent or diminished lower limb or foot pulses on physical examination. A simple clinic test known as the Ankle-Brachial Pressure Index (ABPI) or an ultrasound scan of the lower limb arteries can help confirm the presence of PAD. Over time, if left untreated, these patients may gradually find that they can no longer walk or exercise for long without pain. As a result, many of these patients find themselves limiting their mobility to avoid the pain. Even a walk downstairs to the nearby market may become very difficult.

2) Critical Ischaemia and Tissue Loss

This second group comprises patients who progress from intermittent claudication to pain even at rest, especially when lying down. They may also notice that the affected lower limb is cold and pale. Relief is obtained from keeping the limb in a dependent position (gravity improving blood flow) and patients frequently sleep sitting in a chair. Some of these patients may go on to develop non-healing foot ulcers or gangrene of the toes/foot. They can have underlying tissue or bone infections and may develop life-threatening systemic sepsis from the infected ulcer/gangrene. Other signs include absent limb
pulses and pus discharge from the wounds. These patients require very urgent treatment as they have a significant risk of undergoing major below-knee or above-knee amputations resulting in limb loss.

**Therapy and Treatment Approach**

Patients with diabetes and PAD can benefit greatly from a holistic 3-prong approach to prevent major lower limb amputations:

1) **Control of risk factors and exercise therapy**

This forms the cornerstone of treatment for patients with diabetes and PAD. Our aim is for patients to have optimal blood glucose, cholesterol and blood pressure levels. This can be achieved by taking the correct types of medication in the right doses to control these risk factors. Patients are also started on anti-platelet drug therapy (aspirin or clopidogrel). Anti-platelet therapy has been proven in PAD patients to reduce the risk of developing a heart attack or stroke. For patients with Intermittent Claudication, exercise therapy is also encouraged. This involves getting patients to continue walking despite the pain. The aim of the exercise therapy is to encourage smaller collateral arteries to enlarge and grow so as to induce new supplementary blood supply to the limb muscles.

2) **Improvement of arterial blood flow**

Another key pillar of treatment involves improving the blood flow in the narrowed and blocked main arteries to the limb. This can be done using minimally invasive angioplasty, stenting techniques or open bypass surgery.

Increasingly, more and more patients are being offered and have chosen to undergo minimally invasive angioplasty and stenting procedures. The angioplasty procedure is done via a small puncture wound in the groin artery or the foot arteries, under local anaesthesia and light sedation. A guidewire is then used to cross the narrowed or blocked artery, followed by an angioplasty balloon to dilate the affected segment so as to re-open or widen the artery again. In stenting, special metal stents are used to keep the arteries open after the initial angioplasties in order to prevent repeat narrowing or blockage. Other special devices can also be used to keep the arteries open longer and these
include special cutting balloons, as well as drug-eluting (drug-delivering) angioplasty balloons and stents.

In open bypass surgery, the patient’s own lower limb vein is first harvested and then used as a conduit to bypass the blocked artery. Sometimes, an artificial blood vessel graft is used in place of the patient’s own vein. Open bypass surgery is effective and has good durability, akin to starting a new highway of blood flow. However, open bypass surgery candidates have to be medically fit to undergo the surgery and accept long incisions. Patients also have the open bypass surgery carried out either under general or regional anaesthesia. Recovery from open bypass surgery can be slow because of the painful incision wounds.

When comparing treatment options, angioplasty and stenting may not offer as much durability as an open bypass surgery. Patients may require repeated angioplasty procedures to keep the arteries open on a long-term basis. However, the key upside of angioplasty and stenting is that the morbidity and mortality risks to patients are reduced significantly. Many patients with multiple co-morbid diseases or those who are older who may otherwise be unsuitable candidates for open bypass surgery may now benefit from angioplasty and stenting. These patients can also be discharged home earlier compared to patients who have undergone open bypass surgery. Angioplasty also allows vascular surgeons to treat multiple target arteries in the lower limb as opposed to one artery in open surgery.

With the constant improvement of techniques and technology, most patients are now offered an angioplasty/stenting first approach to improving the lower limb arterial blood flow instead of open bypass surgery. Patients should have a good discussion with their vascular surgeon who can better advise them on which type of procedure they should undergo should they need intervention and also help them understand the pros and cons of each procedure.

3) **Control of wound infections**

The third pillar is early and adequate treatment of wound infections. When detected early, antibiotics can be prescribed according to wound cultures targeting specific bacteria. Infected tissues are extensively removed while taking care to preserve a functional lower limb and foot. Major amputations are avoided unless absolutely required. After surgery to remove infected tissues, the resultant wounds are then cared for using a wide-range of techniques. These include special anti-bacterial and negative pressure wound care dressings. Sometimes skin/muscle flap or skin grafts may be required to cover
the wounds so as to accelerate wound healing. This process then allows the patient to regain their mobility and resume their activities of daily living.

**Early Intervention = Good Outcomes**

Early intervention for diabetics with PAD is crucial in ensuring good outcomes. The rapidly improving techniques and technology such as angioplasty and stenting now offer most patients a lower risk solution to saving their lower limbs. When combined with advanced wound care techniques, patients whose options for limb salvage were once limited can now look forward to avoiding limb loss. The main aim is to keep patients walking, thus maintaining their quality of life.
Fig 1: An angioplasty balloon used to dilate a narrowed lower limb

Fig 2: A metallic stent that is used to keep an artery open after balloon angioplasty
Fig 3: Superficial femoral (thigh) artery: before angioplasty (Left), angioplasty using drug eluting balloon (middle), angiogram post-angioplasty showing widened artery with good blood flow (right)

Fig 4: Superficial femoral artery angiogram showing: narrowed arteries (left), stent in-situ (middle) and post-stenting showing wide and open artery (right)