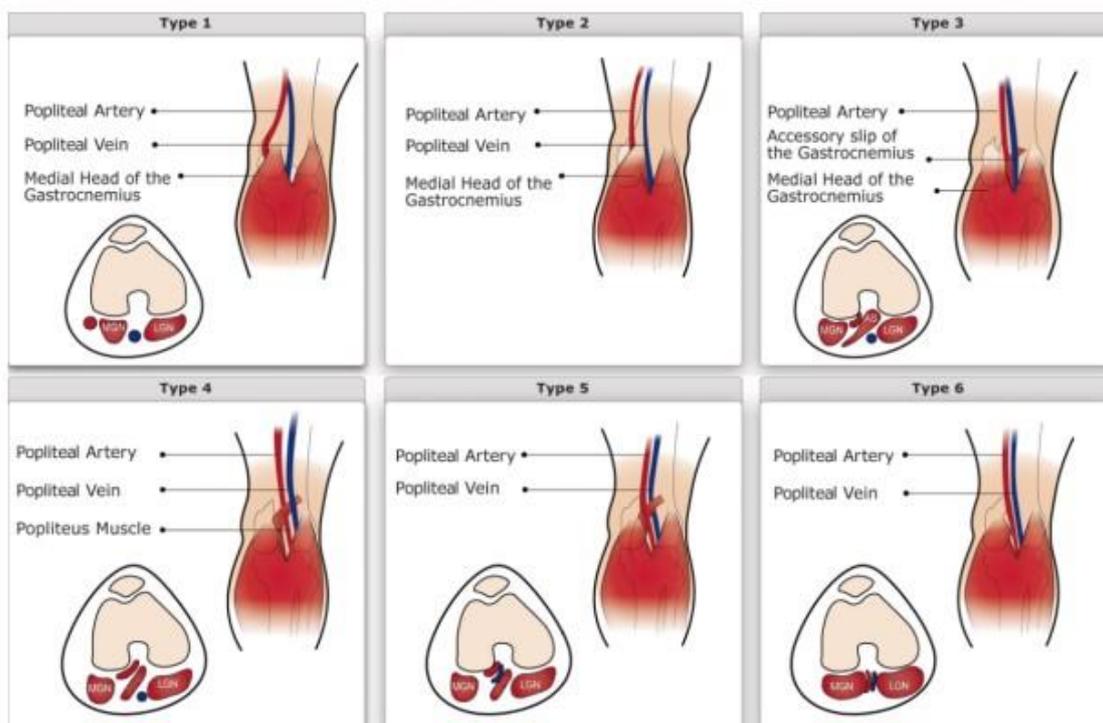


Introduction

Popliteal Artery Entrapment Syndrome (PAES) is a condition where the artery behind the knee is either trapped or compressed by the muscles around the neurovascular bundle (nerve, artery and vein) as they travel through the area behind the knee called the popliteal fossa. The syndrome is often said to be uncommon though is now more commonly recognised and diagnosed and predominantly affects younger people. The syndrome can be divided into different types and different classifications are described. Most commonly however, there are 6 types of PAES that are recognised as shown in the diagram and table below.



Syndrome Type	Underlying Anatomic Abnormality
1	Aberrant medial course of the popliteal artery around the normal medial head of the gastrocnemius muscle
2	Aberrant lateral insertion of the medial head of the gastrocnemius muscle on the distal femur, with resultant medial displacement of the popliteal artery
3	Abnormal accessory slip of gastrocnemius muscle
4	Fibrous band or popliteus muscle
5	Any abnormality causing entrapment of the popliteal vein as well as the artery
6	Hypertrophy of the gastrocnemius muscle

The types of PAES can be simplified into anatomical and functional types. Anatomical includes types 1-5 in the above classification with functional being type 6. Functional PAES (compression rather than entrapment) is the most common variant diagnosed with true anatomical entrapment being rare.

Symptoms

PAES typically presents with exertional pain within the calf muscle following exercise/walking which is then relieved by rest in younger people. In medical terms, this symptom is called claudication. This is a common symptom in arterial disease in elderly patients due to atherosclerosis (hardening of the arteries) though is an unusual symptom in young patients. Unfortunately, PAES is not necessarily well known about in the general medical community. For this reason, the diagnosis of PAES is often made quite late, as young people are not expected to have arterial disease. Patients can also present with atypical symptoms with pain particularly in the foot rather than the calf. It is felt that some of the symptoms associated with PAES may in fact also relate to nerve compression as the nerves to the lower part of the leg travel immediately adjacent to the artery and vein. This would account for atypical symptoms seen in some patients. There are of course many other conditions that can be associated with exertional pain in younger patients, particularly as many patients with PAES are active sports people, especially with functional PAES. A table outlining some of the differential diagnoses in PAES is shown below. The differential diagnoses include Medial Tibial Stress Syndrome (MTSS), stress fractures, Chronic Exertional Compartment Syndrome (CECS) and cystic adventitial disease of the popliteal artery (not included on the table below, another rare non-atherosclerotic disease of the popliteal artery itself).

Table 2: Differential diagnosis and clinical features of exertional leg pain(

Condition	Incidence	Male/Female preponderance	Unilateral/bilateral tendency	Site of pain	Pain present at rest	Pattern of pain
MTSS	13-42%	Possibly female	Bilateral	Posteromedial tibial border	Yes (on palpation)	Pain with activity can warm up and returns on cessation
Stress fracture	Unknown (0.7-20% exercising population)	Possibly female	Unilateral	Variable depending on site of stress fracture	Yes (on palpation)	Pain with impact activity
CECS	27-33%	Nil	Bilateral	Typically anterior and/or deep posterior compartments	No	Crescendo-decrescendo pattern: pain can last for minutes to hours on cessation
PAES (anatomical)	0.6-3.5% (rare)	Possibly male	Possibly unilateral	Typically superficial posterior compartment	Can be at rest (positional)	Crescendo-decrescendo pattern: pain can last for seconds to minutes on cessation
PAES (functional)	Unknown (possibly common and underrecognised)	Possibly female	Likely bilateral	Typically superficial posterior compartment	Can be at rest (positional)	Crescendo-decrescendo pattern: pain can last for seconds to minutes on cessation



Investigations

Investigation for PAES starts with a high index of suspicion and may involve investigations to exclude the other differential diagnoses. In particular, patients may have already undergone or require formal compartment pressure testing to exclude CECS or MRI scanning to assess for MTSS. Investigation for PAES essentially involves a mixture of functional and anatomical assessment to confirm the diagnosis and differentiate anatomical from functional entrapment. Functional assessment will generally be performed in Dr Neale's rooms where we have dedicated vascular sonographers trained in this very specialised assessment. This investigation will include a dynamic ultrasound assessment looking at the popliteal artery behind the knee with the patient standing at rest and then with active contraction of the calf muscles (by standing on tiptoes) to demonstrate compression. The arterial pressure in the leg will also be assessed at rest and following exercise (involving placing a blood pressure cuff around both ankles as well as an arm). Exercise will usually involve the patient running up and down stairs until such time as symptoms occur. These studies will essentially confirm or exclude PAES and also give an indication as to where the entrapment may be occurring. This is because the entrapment may be related predominantly to the medial head of the gastrocnemius muscle (MHG) or occur further distally at the level of the soleus muscle (soleal arch). This differentiation is important as the level of entrapment will be important in determining the options and approaches for treatment (discussed in the next section). The ultrasound investigations however will not be able to definitively differentiate a true anatomical entrapment from functional entrapment. For this reason, a further anatomical investigation will also be required. This will usually involve either a CT scan or MRI scan to assess the anatomical relationship between the popliteal artery and muscles. This investigation may have already had been performed prior to review with Dr Neale though the images (not just report) will need to be reviewed by Dr Neale to assess this. These anatomical investigations are probably not as reliable as the dynamic ultrasound to actually confirm the entrapment/compression, even if they were supposedly performed to show this. Dr Neale essentially needs these investigations purely to clarify the anatomical relationships.

Treatment

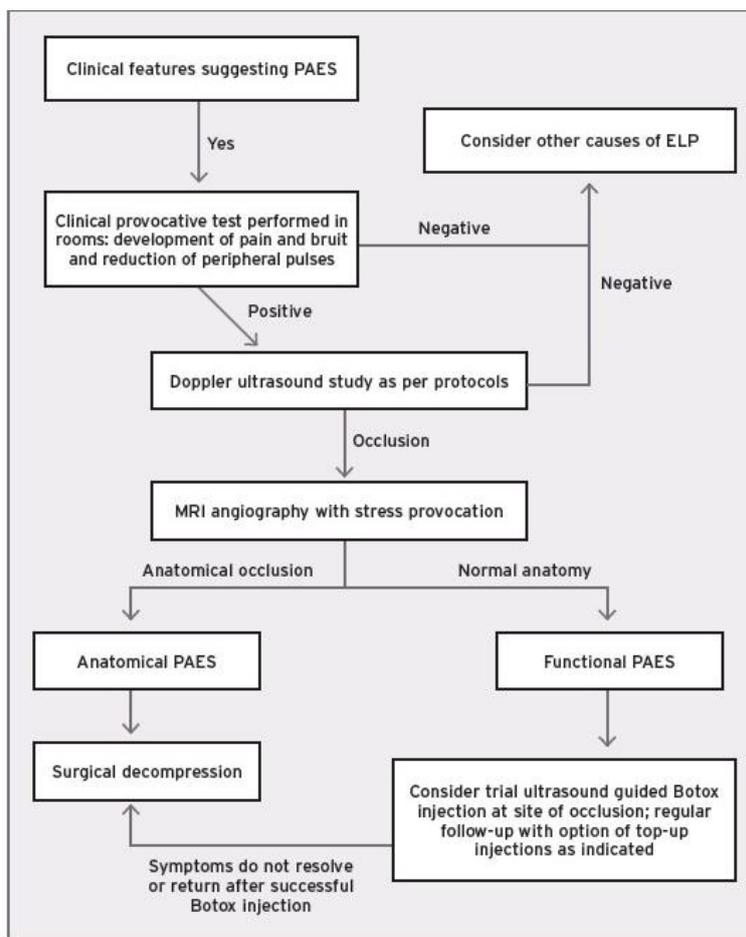
There are various options for managing PAES depending on the severity of symptoms and expectations of individual patients. These expectations will most likely depend on whether the patient is an elite sports person who is limited by symptoms, or whether symptoms are more of concern in relation to recreational activities. In more severe cases, symptoms may also affect general daily activities including normal walking. Essentially, treatment can be divided into 3 options:

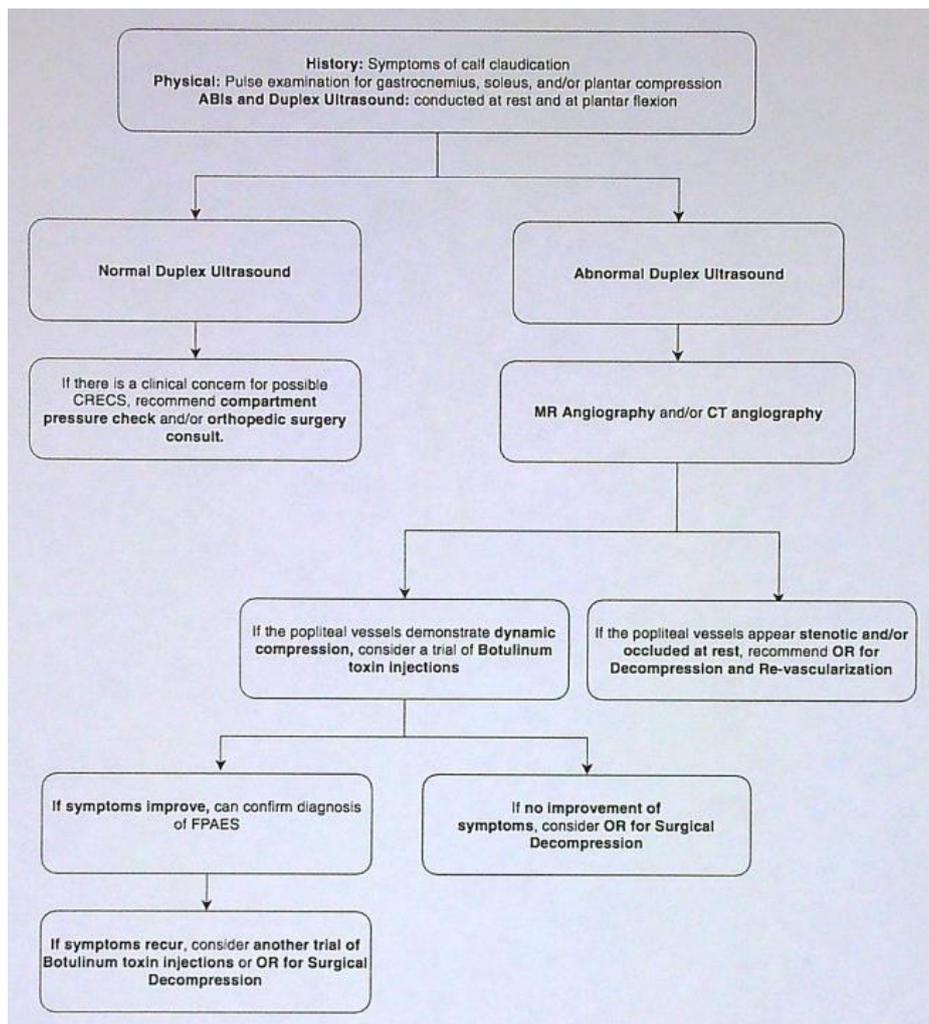
1. Conservative management/reassurance
2. Minimally invasive treatment (use of botulinum toxin)
3. Surgical decompression

Patients diagnosed with anatomical entrapment will almost certainly require formal surgical decompression. Anatomical entrapment can be associated with complete occlusion of the artery and surgical treatment is aimed at correcting the anatomical entrapment and reconstructing the artery if required. Patients with anatomical entrapment without occlusion of the artery should probably undergo elective decompression in order to avoid the future risk of occlusion of the artery. For patients with functional entrapment however, the risk for future occlusion of the artery is extremely low (if not completely without risk).



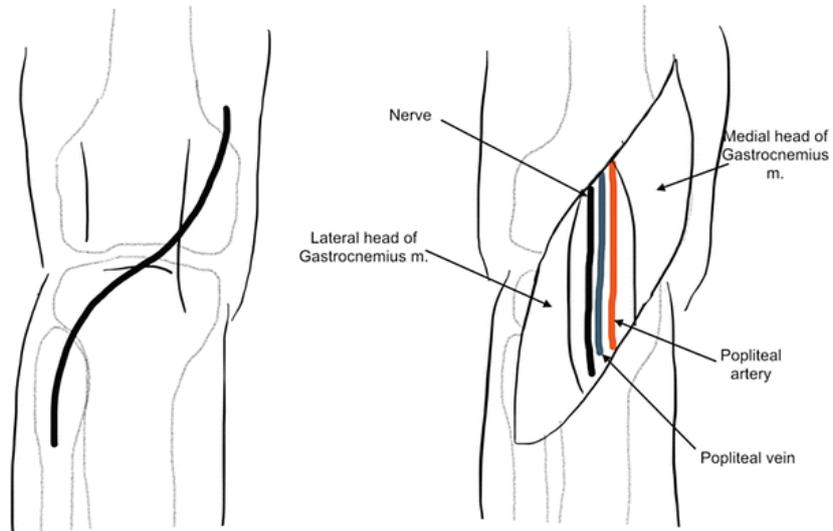
For functional entrapment/compression, all of the above treatment options are available. If a patient is able to adjust their lifestyle to live within the limitations of their symptoms (by either adjusting their expectations to a level of exertion that does not cause symptoms or by adjusting the type of activity/exercise they perform in order to avoid symptoms), then simple reassurance that the functional PAES is not associated with any other long-term risks may be all that is required. For patients however where symptoms associated with functional PAES are severe enough to interfere with a patient's quality of life or ability to perform at a level that is acceptable for them (particularly in the elite sports people), options for treatment include use of botulinum toxin as well as surgical decompression. Surgical decompression would be considered the gold standard with the use of botulinum toxin being a relatively new technique which is however showing some promise as a non-invasive method of treatment, particularly for PAES involving the medial head of gastrocnemius muscle (MHG). This treatment however does not appear to work as well for entrapment involving the artery in its lowest (distal) portion, at the level of the soleal arch. Treatment involving the use of botulinum toxin essentially involves injection of the toxin directly into the MHG (and/or other muscles) and is generally performed by an interventional radiologist. Dr Neale will be able to discuss whether this may be an option for you at the time of consultation. The main disadvantage for the use of botulinum toxin at present is that it does not attract a Medicare rebate at this point in time and so will involve a direct out-of-pocket expense for treatment. For some patients therefore (including patients employed in our defence forces who do not recognise this treatment), this will not be an option and a surgical approach would be most appropriate. Two algorithms outlining management pathways are included below. These both summarise very well the current approach used by Dr Neale in dealing with PAES.



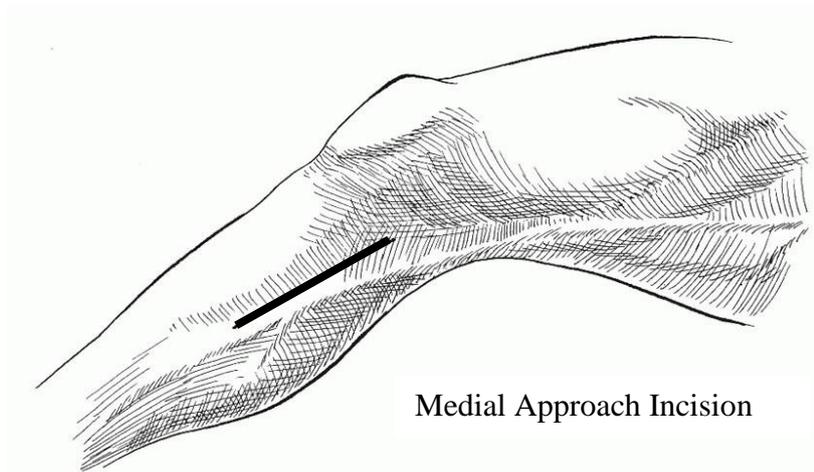


Surgery

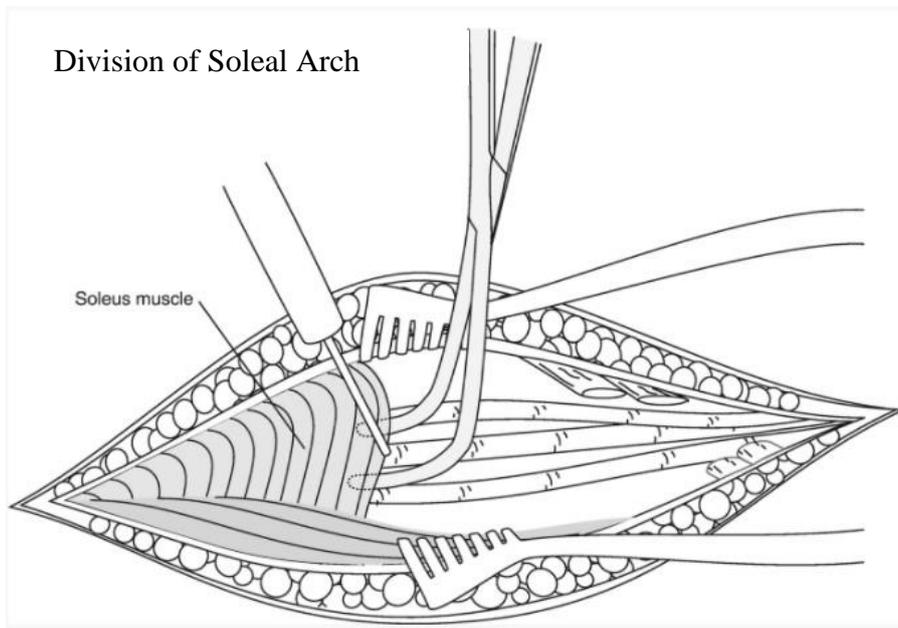
Surgery for PAES would be considered the gold standard of treatment. There are however different approaches to surgery depending on where it is felt the entrapment/compression is occurring. These approaches can essentially be divided into surgery performed behind the knee (posterior approach) or surgery performed through the inner aspect of the calf just below the knee (medial approach). Surgery via a posterior approach would generally be performed for PAES involving the MHG for either anatomical or functional entrapment. Surgery via a medial approach would generally be performed for PAES involving the more distal soleal arch region. Unfortunately, a proportion of patients will require decompression via both approaches (generally done on separate occasions) as both areas ultimately will need decompression (up to 20% of patients). Initial surgery would be directed towards where it was felt the most severe problem was located. Surgery would generally involve 2-3 nights in hospital and would be performed on 1 leg at a time. On hospital discharge, patients will often need the assistance of a crutch for walking, though would hopefully be able to discard this soon after discharge. You will be asked not to undertake any strenuous activity for 3 to 4 weeks post operatively but to simply gradually increase your walking. After 4 weeks you should be able to gradually increase your level of exercise with the only limitations being comfort of the leg. Some simple diagrams showing the different approaches are included below.



**POSTERIOR APPROACH TO
POPLITEAL ARTERY**



Medial Approach Incision



Division of Soleal Arch

Outcomes and Risks of Surgery

There are no guarantees in relation to the outcomes of surgery for PAES. This relates mainly to the complex nature of symptoms in many patients with PAES and the lack of any specific investigations that can prove any relationship between symptoms and PAES. The potential outcomes of surgery can be simply summarised therefore in the following possibilities.

- 1) Complete resolution of symptoms
- 2) Partial resolution of symptoms
- 3) No change in symptoms
- 4) Worsening of symptoms (uncommon)

Patients with a true anatomical PAES would be much more likely to have complete resolution of symptoms with correction of the anatomical problem. Whilst complete resolution of symptoms is the aim for treatment in functional PAES, the second possible outcome of partial resolution of symptoms is probably the more likely outcome. Most patients will have sufficient relief of symptoms to significantly improve their quality of life even if complete resolution of symptoms is not achieved with their initial operation. As previously indicated, some patients will require a second operation from the other approach from originally (posterior or medial) due to the inability to completely decompress the artery higher up or lower down, due to the limitations of each approach, in order to achieve a satisfactory level of symptom relief. Unfortunately, and unpredictably, some patients will have no relief of their symptoms following treatment. Assuming satisfactory decompression has been achieved, this would imply that the symptoms were not necessarily related to the popliteal artery entrapment/compression. If all other possibilities have already been excluded, it is not always possible to identify the source of these symptoms. Review of the other possible diagnoses in this setting may need to be revisited with referral back to other specialists/sports physicians as appropriate. A minority of patients may feel that their symptoms are in fact worse than preoperatively, possibly due to complications related to the surgery (see below).

All surgery is associated with some risk. Surgery is of course always carried out with care in order to minimise the potential for complications, however complications are often unpredictable (and statistics never lie). Surgical risks can be classified into general risks associated with all surgery and risks that are specific to each surgical procedure. Some of these risks will be summarised below. Please do not hesitate to ask Dr Neale if you have any questions or concerns regarding these risks and be aware that there may be other rare or unexpected complications from surgery that may not be mentioned here.

General Risks: These risks include risks normally associated with general anaesthetic (and should be discussed with your anaesthetist if undergoing surgery), DVT/PE (deep vein thrombosis/pulmonary embolus), stroke, myocardial infarction (heart attack), other heart problems (e.g. arrhythmia) and death. As PAES is generally a problem of younger patients, these risks would all be considered extremely low, assuming no pre-existing conditions. Other general risks include problems associated with wound healing, in particular infection and excessive scar formation (also known as keloid scarring). Wound problems are more likely with the posterior approach due to the constant movement of the wound across the knee with regular walking and exercise. This is the main reason to limit activity during the first 3 to 4 weeks in patients with a posterior approach in order to minimise risks associated with the wound.



Specific Risks: Specific risks associated with surgery for PAES involve predominantly the potential for injury to neurovascular structures (nerves, arteries and veins) as these are the structures which are ultimately being decompressed. Injury to these structures can include bleeding requiring major surgical repair, deep venous thrombosis (DVT, blood clots) related to injury to the popliteal vein behind the knee and loss of power in the leg due to injury to the main nerves travelling in this area. These risks would be considered very uncommon (1% or less). There are also sensory nerves which can be involved with the surgical approach resulting in patches of numbness in the skin. With a medial approach, this will typically be down the anterior surface of the shin and possibly extending onto the top of the foot. With a posterior approach, the area of numbness would be in the posterior part of the calf (back of the calf) with a small risk of extension onto the undersurface (sole) of the foot. Small areas of numbness may gradually resolve over time whilst larger areas are likely to reduce though not resolve completely. Return of sensation through these areas can take up to 2 years. There is also a small risk for hypersensitivity or pain (neuropathic pain) related to the sensory nerves. Perhaps the main risk of the surgery is the already mentioned possibility of a failure to relieve the patient's symptoms.

Follow-Up Following Treatment

For people undergoing treatment with botulinum toxin, follow-up is very important as this is still a relatively new technique. You will be asked to make a follow-up appointment with Dr Neale for further functional testing (ultrasound and exercise pressure testing) as well as clinical assessment with Dr Neale to correlate the testing with clinical outcome of the treatment. These outcomes will determine any further need for treatment and type of treatment. Dr Neale will be able to discuss this with you further at the time of the follow-up.

Follow-up following surgical treatment will involve initial clinical review with Dr Neale usually at 4 to 6 weeks post operatively. If all is going well at this time, you will be able to then gradually increase activity without restriction within the limits of how the leg itself is feeling. Depending on the outcome at this stage, possible timing for intervention in the other leg (if required) or any further investigation and intervention in the same leg can be determined. Full recovery from surgery can take many months. Further follow-up arrangements and need for further investigations will be assessed at the initial follow-up, depending on clinical progress.

Please do not hesitate to contact Dr Neale's rooms for a further appointment should any further clarification be required or should you have any further questions, particularly prior to proceeding with surgery for management of PAES. You will also be provided with a surgical estimate outlining the anticipated costs associated with surgery (including Medicare and private health fund reimbursements and out-of-pocket expense) as well as an information sheet regarding these fees and other possible expenses.

