Does the anatomical position of the motorcyclist impact venous return?

KEY WORDS
- Compression therapy
- Health promotion
- Motorcyclist
- Venous disease
- Venous return

While most motorcyclists focus on the maintenance of their motorcycle and personal safety equipment, recent research has highlighted the impact of motorcycling on lower-limb health. This article underlines the importance of regular health checks to recognise early warning signs of venous disease and how health promotion initiatives linked to preventative strategies may help to minimise the risk of developing venous leg ulcers in this difficult-to-reach population.

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Venous insufficiency is a common cause of leg pain and swelling and, if left untreated, can lead to varicose veins and venous ulceration in later life. Venous leg ulcers can be difficult to heal, often reoccur, and represent a significant cost to the NHS (Ragnarson Tennvall and Hjelmgren, 2005; Posnett and Franks, 2008).

Immobility and extended periods of standing or sitting are known to contribute to venous insufficiency (Hitos et al, 2007; Sandbrink et al, 2009). However, while the risk of developing deep vein thrombosis (DVT) during long-haul flights has been recognised for some time, little attention has been paid to the risks of long-term, or long-distance, motorcycle riding and the impact on circulation in the lower limbs.

BACKGROUND

What causes chronic venous insufficiency?

The venous system comprises a deep vein system (within the muscle fascia) and superficial system (nearer the surface), which are joined by perforator veins, linking the two systems. The deep veins of the leg are the femoral, popliteal, and tibial veins, while the superficial veins are the great and small saphenous veins. The popliteal vein is located behind the knee, and connects to the femoral vein in the upper leg and runs up into the groin. The perforator veins allow blood to flow from the low-pressure superficial veins into the high-pressure deep veins (*Figure 1*).

In a normal resting subject, the pressure in the veins at the ankle is largely controlled by gravity. When lying flat, the venous pressure approaches zero, while, when standing. the pressure increases to in excess of 100 mmHg. As the subject exercises, the venous pressure falls. This is due to the action of the calf muscle pump. As the calf muscle contracts, it gently squeezes the deep veins causing the valves to open, allowing blood to pass through. Non-return valves in the veins prevent backward flow of blood when the muscles relax (*Figure 1*). Pressure slowly returns to the higher level when the subject rests again (Vowden and Vowden, 2013).

However, if the valves are damaged due to varicose veins, DVT, trauma, or venous obstruction, they allow blood to flow back down into the section of the vein below (venous reflux). This prevents the reduction in venous pressure at the ankle that normally occurs during exercise, resulting in venous hypertension. This may be exacerbated by failure of the calf muscle pump due to inactivity, ankle immobility, or abnormal gait (Anderson, 2008; Fletcher et al, 2013).

Recognising the signs of venous disease

Chronic venous insufficiency is a progressive condition, both in terms of deteriorating venous function, and in the development of secondary skin changes (Vowden and Vowden, 2013). The initial effects of venous insufficiency may present as throbbing, cramping, burning sensations, or leg fatigue. Venous dilatation at the ankle (ankle flare) may occur due to distention of the superficial vein, and is one of the earliest signs of venous disease. If left untreated, this may progress to the development of varicose veins, with skin changes

such as haemosiderin staining (blue–purple or rusty coloured), atrophy blanche (areas of pale, scar-like tissue) or hardening of the affected area, with or without swelling (Vowden and Vowden, 2012).

Other warning signs include redness and skin marks from clothing, tingling sensation, itchy dry skin, scaly or leathery skin, or red patches of skin between the knee and ankle. These skin changes may feel hot in the early stages of venous disease and may be misdiagnosed as infection.

Are motorcyclists at high risk of venous disease?

Riding a motorbike requires total concentration, with the motocyclist and machine at one, often for long periods of time. Motorbike design means that motorcyclists need to adopt a position of acute lower-limb flexion, at both knee and hip, which can compress the veins and restrict the blood flow to the surrounding tissues (*Figure 2*). Although this may only cause saddle discomfort, or "tired legs", in the short term, in the long term, it may lead to irreversible damage to the venous system (Lindsay et al, 2013).

The saddle discomfort often tolerated by many motorcyclists may be exacerbated by the wearing of tight leathers and protective clothing. While these are essential for safety reasons, they can create local pressure points, especially behind the knees, with compression of the popliteal vein. Moisture under the protective leathers can also build up, causing the skin to become overhydrated and vulnerable to the effects of friction, which can lead to skin breakdown (Lindsay et al, 2013).

ASSESSING LEVEL OF RISK

To help quantify the prevalence of lower-limb problems among motorcyclists, a questionnaire survey was undertaken (Lindsay et al, 2013). Over a period of 4 years, motorcyclists attending 2-day major motorcycling events were invited to complete a questionnaire on demographics (*Figure 3*), motorcycle usage and attitudes to risk and lower-limb health.

Of 767 respondents, 332 (43%) reported experiencing leg cramps during journeys and 149 (21%) immediately following motorcycling. Many motorcyclists reported typical symptoms of chronic venous insufficiency, including itchy skin, restless leg syndrome and aching, and swollen legs, suggesting that the anatomical position adopted when motorcycle riding may be a contributing factor in the development of lower-limb venous disease.

Figure 1. Diagram showing the venous drainage of the lower limb, with a detail of the non-return valves in veins that prevent backward flow of blood.

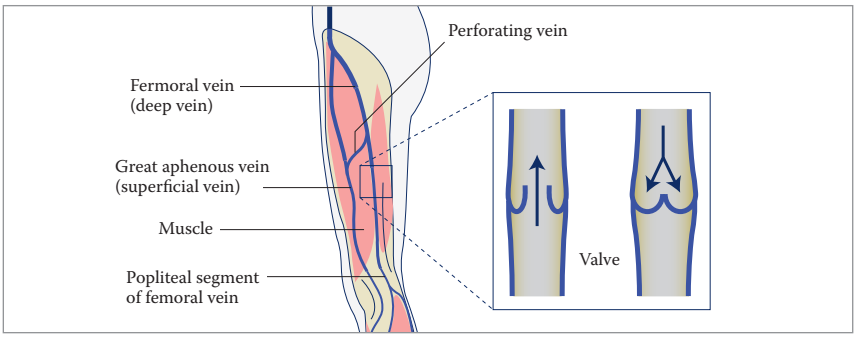


Figure 2. Diagram outlining how motorbike design means that motorcyclists need to adopt a position of acute lower-limb flexion, at both knee and hip, which can compress the veins and restrict the blood flow to the surrounding tissues.

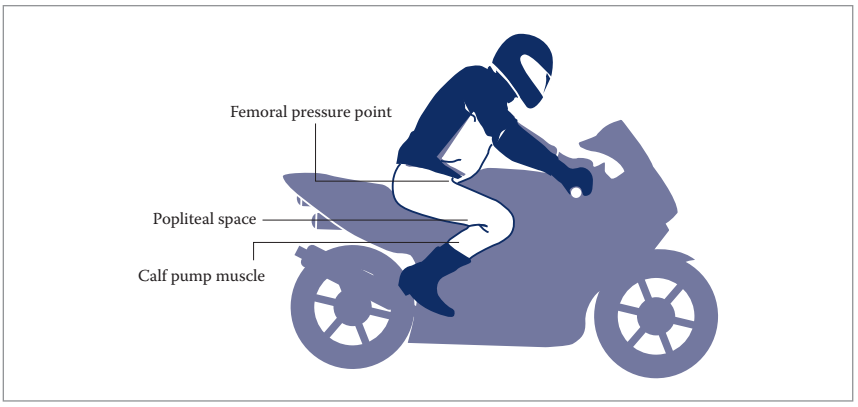
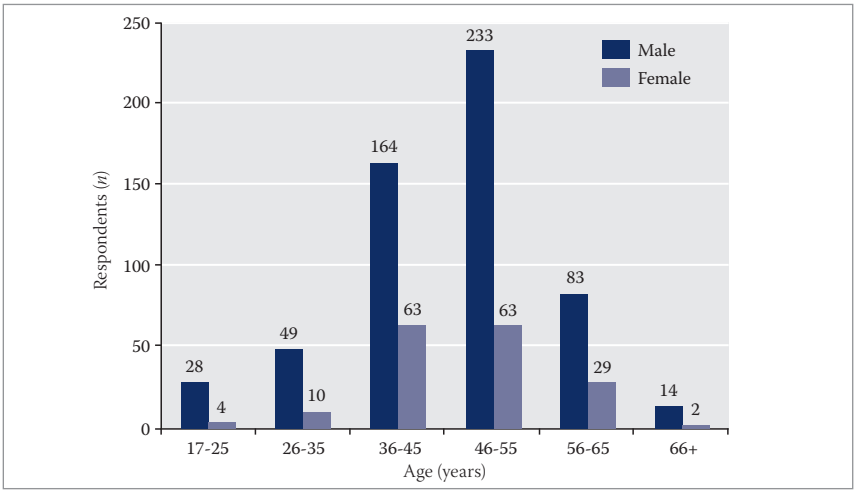


Figure 3. Age and gender of motorcyclists attending 2-day major motorcycling events who responded to a questionnaire on motorcycle usage and attitudes to risk and lower-limb health.



"When placed in the bike riding position, 16 (53.3%) of the 30 limbs tested showed decreased emptying compared with the standard sitting results, with 7 (23.3%) limbs showing a marked pattern of obstruction."

Responses to the questionnaire also suggested that motorcyclists respond to perceived risks (e.g. risk of injury), but are much less likely to respond to threats that are long term and have minimal short-term symptoms. Following explanation of the benefits of compression socks / hosiery, only 40% stated they would wear compression hosiery (*Figure 4*).

A pilot study using venous photoplethysmography (PPG) aimed to quantify the effect of motorbike riding position on venous function has been undertaken. A conventional PPG test was conducted with the subject seated with the hip and knee flexed at approximately 110˚ (*Figure 5*). This was compared with a similar test in which the subject was seated in a typical sports bike riding position, with an acutely flexed knee and hip and dorsiflexed ankle. In both tests, ankle flexion extension exercises were performed to record the efficiency of the calf muscle pump and venous return. All 15 subjects were given training for the exercises to ensure a high level of consistency when performing the tests (Lindsay et al, 2013).

The results showed that venous refilling times were similar when the test was performed in the sitting or riding position, with 50% of subjects having abnormal or equivocal refill times. However, during the exercise phase (ankle dorsiflexion), the results were markedly different between the two testing positions. Of the 30 limbs tested, four (13.3%) demonstrated abnormal emptying with a pattern of partial venous obstruction in the sitting position. When placed in the bike riding position, 16 (53.3%) of the 30 limbs tested showed decreased emptying compared with the standard sitting results, with 7 (23.3%) limbs showing a marked pattern of obstruction (Lindsay et al, 2013). Research is ongoing to establish whether positional popliteal venous obstruction is occurring in a bike riding position and how this contributes to impaired venous function among motorcyclists.

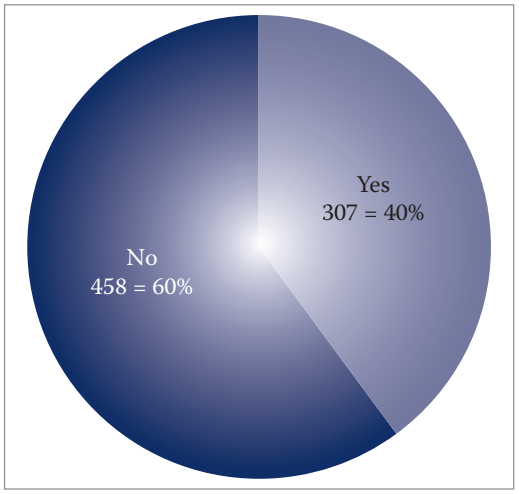


Figure 4. Responses from motorcyclists who were asked whether they would wear compression garments, following explanation of the benefits of compression socks / hosiery.

REDUCING THE RISK OF VENOUS ULCERATION

Early intervention can prevent progression of venous disease and development of venous ulceration in later life (Timmons and Bianchi, 2008). Prevention is also integral to the government's Quality, Innovation, Productivity and Prevention (QIPP) agenda, with the opportunity to alleviate future care cost and service demands on the NHS (Department of Health, 2011).

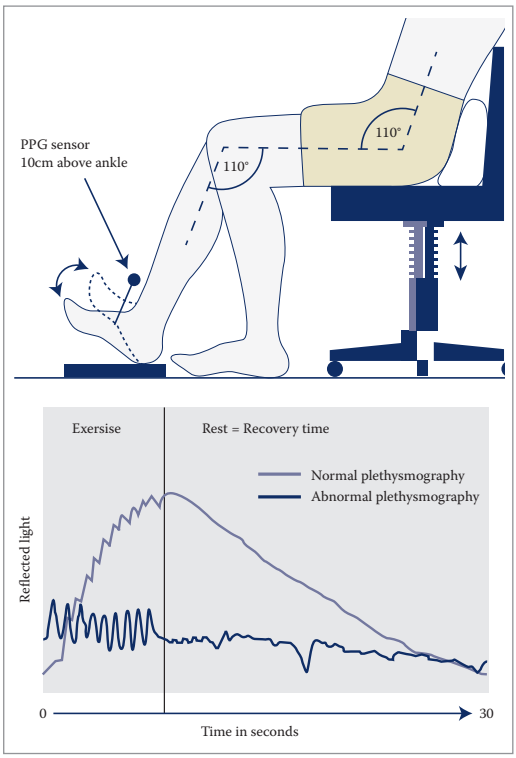


Figure 5. A diagram showing the process of undertaking venous photoplethysmography.

Figure 6. The Lindsay Leg Club Foundation attends and promotes health awareness campaigns at motorcycle clubs and shows around the UK, offering free leg checks and "well leg" education.

Apart from adjusting the bike riding position, motorcyclists can take a few simple precautions, such as taking regular breaks during trips, elevating their legs when sitting, and taking structured exercise to improve venous circulation, calf muscle function, and joint mobility. Other simple interventions include:

- Addressing diet and lifestyle factors.
- Implementing a daily skin care routine, such as using simple moisturisers to maintain skin health.
- Wearing compression hosiery.

The Lindsay Leg Club Foundation provides some general advice for motorcyclists and their passengers on the maintenance of healthy legs at: www.legclub.org/downloads/motorcyclists.pdf.

The role of compression hosiery

Compression therapy (either bandages or hosiery) is the mainstay of preventing and treating venous leg ulcers (Vowden and Vowden, 2012; Nelson and Syers-Bell, 2013). Compression aims to counteract the force of gravity and promote the normal flow of venous blood up the leg (Partsch, 2003).

Motorcyclists should be advised about the benefits of using compression hosiery in relieving aching and throbbing legs and as a preventive measure for venous ulceration. Individuals with early signs of venous disease can purchase Class 1 stockings over the counter or, where there are more advanced signs, they should be referred for a full assessment. It is important to measure the leg and select appropriately sized hosiery with the correct compression level (World Union of Wound Healing Societies, 2008; Vowden and Vowden, 2012). Individuals should be shown how to apply the hosiery and understand when to wear the garment. In this way, motorcyclists can be encouraged to self-manage, under the guidance of a healthcare professional, to improve their concordance with compression therapy.

Ensuring concordance

The majority of motorcyclists who participated in the questionnaire survey described above had a positive attitude towards their health, placing importance on regular exercise (Lindsay et al, 2013). However, there is still a gap between how they perceive health and what they do to achieve prevention of lower-limb problems. Despite giving information and talking to the motorcyclists, many (particularly younger men) give various reasons for not accepting compression socks/hosiery with many quoting the "Nora Batty" look as a deterrent.

Advances in stocking designs means that graduated compression hosiery looks and feels like regular men's socks and are available in a range of colours, including black. The challenge now is for industry to develop marketing strategies specifically targeting this at-risk group to improve acceptability.

There are more than 1.5 million motorcyclists in the UK and targeting this predominately male, mixed-age group is challenging. To address this, the Lindsay Leg Club Foundation collaborated with Police BikeSafe, BMW, the Institute of Advanced Motorcyclists, and the British Motorcyclist Federation. With the support of these groups, the Lindsay Leg Club Foundation now attends and promotes health awareness campaigns at motorcycle clubs and shows around the UK, offering free leg checks and "well leg" education (*Figure 6*).

CONCLUSION

Chronic venous insufficiency results from damage to the valves in the veins of the leg and inadequate functioning of the calf muscle pump. Taking regular breaks during trips to relieve pressure, exercising regularly, and considering body position on the bike can help to stimulate calf muscle pump function and aid venous return. In addition, clinicians can advise motorcyclists on the importance of improving their diet/lifestyle choices, and to take care of their skin to prevent deterioration and ulceration.

Importantly, motorcyclists should be encouraged to consider graduated compression hosiery as an essential element of their protective clothing. Such measures – supported by targeted education – can help to minimise the risk of venous ulceration among motorcyclists. Research is ongoing to determine the impact of anatomical position on venous return and evidence of correlation with factors, such as rider age, journey time, and class of motorcycle. WUK

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