

# Stroke Volume, Orthostasis and Leg Exercise – Case Study



The measure of life.

## USCOM Case Study

### Stroke Volume, Orthostasis and Leg Exercise

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#### Background:

Orthostasis, literally meaning "standing upright", is associated with a complex series of cardiovascular responses mediated by sympathetic and parasympathetic regulation to maintain regional perfusion in spite of the gravitational forces acting to pool blood in the dependent leg veins. It is known that prolonged still standing results in increased lower leg pressures and cerebral hypotension as blood pools under the force of gravity in the dependent veins. The lower leg veins dilate with increasing volume producing an increase in peripheral pressure, preload is depleted and SV is diminished. If this position is maintained without movement and cerebral hypotension increases, the end point is fainting, as occurs on the parade ground. Horizontal positioning then restores blood distribution, blood pressure, cerebral perfusion and consciousness. It is also known that movement of the lower limbs acts to support the heart as a circulatory pump. This single observation quantitates SV changes associated with this physiologic phenomena.

#### Method:

Normal adult male (38yrs) still standing for 5 minutes had an aortic haemodynamic assessment using USCOM, with re-examination after two bilateral leg flexes.



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## Results:USCOM examinations

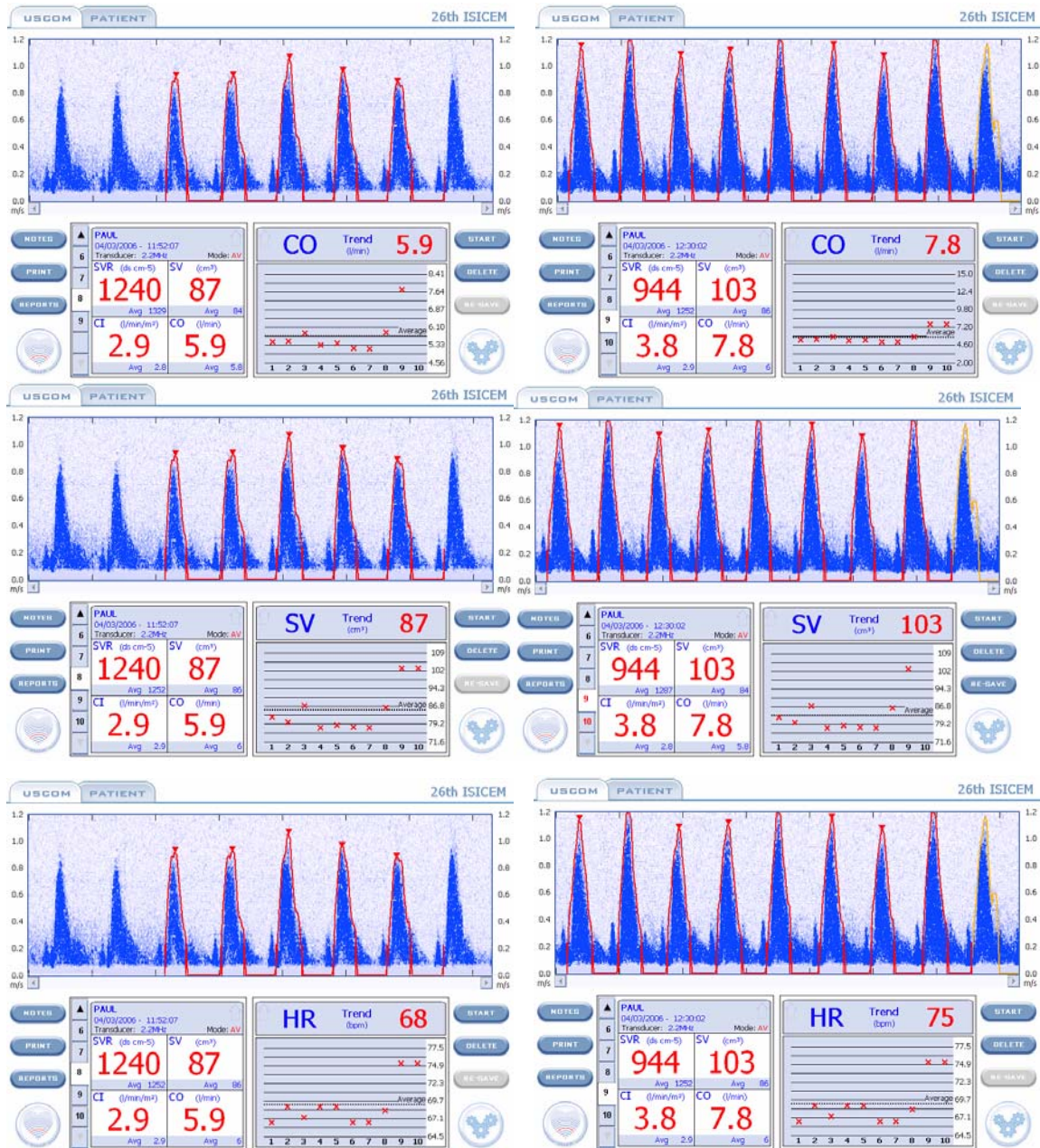


Figure 1. Aortic USCOM screen shot of output flow profiles after prolonged still standing (left) and after limited leg flexing (right) demonstrating increases in SV, CO and HR parameters and an associated decrease in SVR



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There were instantaneous changes in central haemodynamics measured by USCOM in response to the leg exercise are displayed in table 1 and figure 3.

	CO (L/min)	SV (cm <sup>3</sup> )	HR (bpm)	SVR (dynes.s.cm <sup>-5</sup> )
<b>Standing</b>	5.9	87	68	1240
<b>Leg flex</b>	7.8	103	75	944
<b>% Change</b>	<b>+32</b>	<b>+18</b>	<b>+10</b>	<b>-8</b>

Table 1. USCOM values after prolonged standing and after two bilateral leg flexes.

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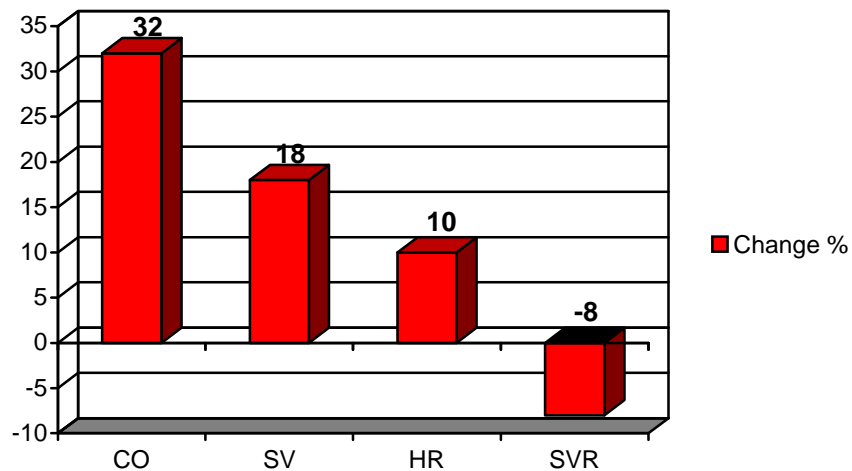


Figure 1. % changes of USCOM parameters after leg flexing referenced from standing values.

In summary SVR decreased, while CO increased by component increases in both SV and HR.

## Discussion:

These observations demonstrate that cardiovascular physiology is dynamic and variable, even during inactivity, as may occur in hospitalized subjects. The observed



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decrease in SV during standing is secondary to blood pooling in dependent extremities and diminishing the preload. The blood pooling results in increased peripheral venous pressures and SVR, and progressively reduced venous return, reducing preload and ultimately reduced SV. In the absence of an active pump support, such as leg motion, this process will continue. In this example simply flexing the lower limbs was sufficient to shift the pooled blood back into circulation, filling the atria and increasing the SV.

## Conclusion:

CO is a complex and variable entity, affected by subject position and the interaction of multiple complex entities, including autonomic function, and vascular pressure, a function of vascular compliance and blood distribution. The interplay of vascular pressure and cardiac performance is reflected in beat to beat changes in CO, HR and SV, all of which make the definition of meaningful population defined “normal” haemodynamic values challenging.

## Teaching Points:

Low or high CO may be real but not abnormal, particularly in subjects after prolonged standing or sitting as occurs in hospitalized patients.

Quantitative determination of cardiovascular function is important for the reliable assessment and management of cardiovascular physiology and pathophysiology.

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