Postural hypotension and the anti-gravity suit

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■ An air force anti-gravity suit, as used by fighter pilots to prevent loss of consciousness, has been successfully employed to treat severe postural hypotension in a patient with Shy-Drager syndrome. The definition of postural hypotension is reviewed, and reference is made to the previous use of the anti-gravity suit in the treatment of this condition.

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Postural hypotension may be difficult to treat. As a last resort an anti-gravity suit (anti-G suit) as used by fighter pilots may be useful.

The anti-G suit consists of a non-stretch abdominal belt and leggings containing five distensible bladders (*Figures 1 to 3*). These are inflated through a tube attached to the belt to give counterpressure on the abdomen, thighs and calves. Pressure on the veins in these areas reduces venous pooling and therefore improves venous return and cardiac output, and pressure on the arteries increases their resistance to flow.[1-3] These two actions help to maintain arterial blood pressure.

Patient history

A 62 year old woman with Shy-Drager syndrome for about 13 years was unable to walk. Her symptoms also included a Parkinsonian tremor, no chewing ability and postural hypotension. She had an in dwelling catheter and was confined to a wheelchair. However, the wheelchair had to be tilted back because of her postural hypotension.

An air force anti-G suit (CSU-138/P) was fitted. Her Parkinsonian tremor made accurate blood pressure measurements difficult. With the suit inflated by blowing through the tube the systolic blood pressure (measured with a mercury sphygmomanometer) was about 20–60 mmHg lower with the patient sitting up as compared with lying down (*Table 1*). However, she remained mentally alert while sitting up with the suit inflated. Her husband considered that the antigravity suit had improved her quality of life. Eight months after the suit was fitted she died of respiratory muscle failure and hypostatic pneumonia.

Discussion

In 1960 Shy and Drager described a neurological syndrome associated with postural hypotension in the absence of systemic disease.[4] Postural hypotension was first described in 1925, one of the characteristics being a syncopal attack when the patient stood, with a marked drop in blood pressure.[5] Measurement of blood pressure by auscultation during standing can be difficult if the patient is unsteady, and the disappearance of Korotkoff sounds can be difficult to detect if the blood pressure is low.[6]

An anti-G suit has been used to improve the quality of life of a patient with Shy-Drager syndrome.

It is thus not surprising that there is some variation in the systolic blood pressures described in postural hypotension. A drop of systolic blood pressure of 20 mmHg one minute after standing is regarded as the upper limit of normal.[6] A drop of 30 mmHg, or to 80 mmHg or lower on standing has also been stated as a guideline for postural hypotension.[7] Even lower still was the finding in one study that there were no symptoms or signs of impaired cerebral function as

long as the systolic pressure did not fall below 50 mmHg. In certain instances systolic pressure as low as 40 mmHg were tolerated for 10 to 15 minutes with no apparent loss of mental acuity.[1]

Syncope results from failure to maintain cerebral blood flow, which is normally maintained (cerebral autoregulation) even when systemic blood pressure changes. It fails when the mean blood pressure falls outside the range of 60–150 mmHg. This range may change in elderly people who are used to a high mean blood pressure.[6] Henry and co-workers have emphasised the importance of mean arterial pressure (diastolic pressure plus one third of the pulse pressure) in relation to blood flow. In collecting data from various sources they converted the systolic/diastolic pressures into mean arterial pressures and showed that this can fall below 55 mmHg before symptoms are described. Syncope developed at about 50 mmHg.[8]

As a last resort an anti-gravity suit (anti-G suit) as used by fighter pilots may be useful for treating postural hypotension.

In the patient with Shy-Drager syndrome the mean arterial pressure was 130 mmHg when lying with the suit inflated, fell to 97 mmHg on sitting in the wheelchair, and half an hour later had fallen to 53 mmHg. When asked if she wanted the wheelchair tilted back, she indicated that she did. Obviously this mean arterial pressure was uncomfortable for her. This was the lowest recorded mean arterial pressure (*Table 1*).

TABLE 1

Values of systolic, diastolic and mean arterial pressures. Where multiple measurements were made, average values have been tabulated.

Position	Systolic/diastolic	Mean
Large suit (inflated)		
lying	160/120	133
sitting	143/110	121
lying	157/107	124
sitting	120/100	107
Medium suit (uninflated)		
lying	170/110	130
sitting	110/90	97
(inflated)		
lying	160/115	130
sitting	110/90	97
half hour later	60/50	53
further inflation, wheel chair tilted back	110/85	93

Initially a large regular anti-G suit was fitted, but this was too large, and a medium regular suit was used instead. An unexplained finding on one occasion were identical blood pressure measurements both with the suit uninflated and inflated. The number of blood pressure readings were limited so as not to tire the patient. However, she did not become unconscious when the suit was inflated. It was also observed that the blood pressure on one occasion continued to fall in spite of the suit being inflated. Perhaps the suit was not inflated to a sufficiently high pressure. The same phenomenon has been described in a quadriplegic patient, and it was suggested that a greater pressure in the suit may have maintained the blood pressure.[9]

The value of externally applied pressure in correcting the drop in blood pressure caused by standing has been known for some time. Late in 1940, Professor Frank Cotton showed that the cardiac output, which decreases considerably when a change is made from the supine to the standing posture, is restored nearly to its full supine value when the standing body is surrounded by water up to the xiphisternum.[10] This formed part of his research leading to the development of the Australian anti-G suit during the Second World War.[11]

The use of water in applying external pressure to correct postural hypotension was reported by Stead and Ebert in 1941. They had two subjects with postural hypotension stand in water up to the level of the heart. With the water at this level the arterial pressure and the heart rate were essentially the same as when the subjects were lying down. As the level of the water was lowered, the arterial pressure fell progressively.[1]

A similar discovery was made by the husband of the patient with the Shy-Drager syndrome reported in this paper. He found that his wife, confined to a wheelchair because of postural hypotension, could walk in a swimming pool with

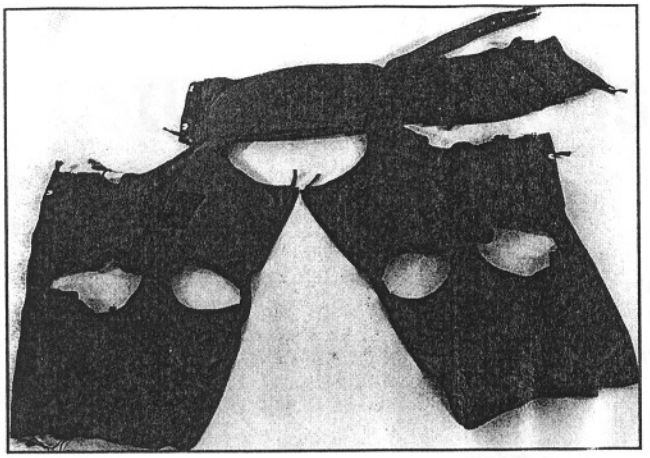

Figure 1. Uninflated anti–G suit to show abdominal belt and leggings.

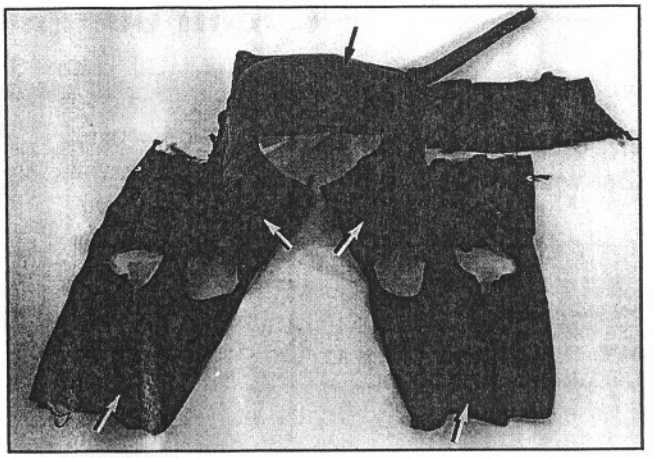

Figure 2. Inflated anti–G suit. The distensible bladders are indicated by the arrows.

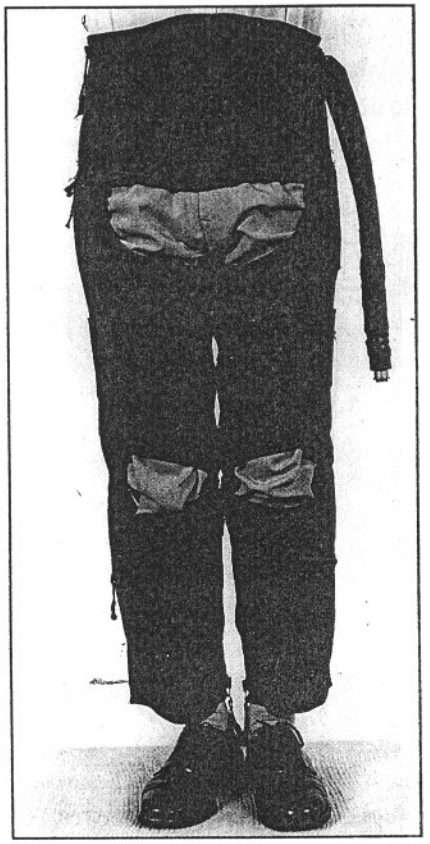

Figure 3. Wearing an inflated anti–G suit.

water up to the level of the heart. Unfortunately by the time the anti-G suit was fitted her neurological condition had so deteriorated that she was unable to walk.

The effective use of an air force anti-G suit in patients with postural hypotension has previously been described.[12-14] A comparison between an air-filled suit (an experimental anti-G suit) and an elastic form of garment providing counterpressure showed that the air-filled suit was more effective in treating postural hypotension.[2] As Burton[13] has pointed out, the anti-G suit is not routinely used clinically to raise blood pressure, and it requires someone to suggest the role. The purpose of this paper is to draw attention to this clinical use of the anti-G suit.

Summary

An air force anti-gravity suit has been successfully used to treat severe postural hypotension in a patient with Shy-Drager syndrome.

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Acknowledgments

Grateful acknowledgment is made to Group Captain R Fawcett and Wing Commander G Boothby for advice on the manuscript. I would also like to thank Ms M Ward of the Department of Medical Illustration of the Faculty of Medicine, Monash University, for providing the photographs. ❑

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