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About orthostatic hypotension in tetraplegic individuals reflections and experience

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The author recalls the role of the autonomic nervous system and the means of investigation of this system in orthostatic hypotension occurring in tetraplegic individuals and the haemodynamic, biochemical and humoral changes which are triggered by upward tilting of such people. He then considers some of the problems that a person who is tetraplegic may encounter during his life. Regular follow up of each tetraplegic person is necessary and includes respiratory function tests as well as 24 h blood pressure monitoring.

Keywords: orthostatic hypotension; tetraplegia; long term quality of life

For a century a number of papers have been published on the various circulatory effects of autonomic dysregulation in certain individuals and experimentally in animal studies resulting from lesions of the spinal cord. [1–6]

Regarding specific scientific works devoted only to orthostatic hypotension (OH) the first to be published was that of Hill in 1895[7] followed by the report of Stead and Herbert[8] in 1941.

In the normal situation, standing up normally requires haemodynamic and biochemical responses which depend greatly on the autonomic nervous system but also on the particular influence of cardiac (resistance and output), renal (baroreceptors), and vascular structures (e.g. concerning the pathology of old age).[9]

In those who are tetraplegic, the loss of vasomotor regulators in the extensive vascular pool in the lower limbs and in the splanchnic territory plays a major part regarding the onset of orthostatic hypotension (OH) and these have been the subject of numerous publications mostly about autonomic hyperreflexia rather than about hypotension. It would be unfair in this article not to mention the important role of Mathias, who has been particularly involved with the topic of hypotension for more than 20 years.[9–12]

The haemodynamic, biochemical and humoral changes which are triggered by orthostatic forces may be summed up as follows:

(1) A reduction of the intra-thoracic and central blood volume (the absence of pumping effect from muscular contractions can also have some influence).
(2) A modest and delayed release of catecholamines already at a low resting level[10,13,14] triggering off the renin-angiotensin system by the renal baroreceptors[11,13,14]
(3) Then, in the absence of a sufficient correction of the OH, a release of ADH and eventually the onset of secondary hyponatraemia.[15–18,20]

It has also been shown that the osmoregulatory system functions normally in spinal injured patients and that hypokalaemia, more pronounced in those who are tetraplegic, co-exists with an increase of the volume of extra-cellular fluids and unstable hyponatraemia. This is also more pronounced in tetraplegic individuals.[15,18] Moreover, the slowing of extent of the cerebral blood flow as shown by the transcranial Doppler technique, does not correlate with the data given by the tensiometer but with the clinical symptoms of OH, demonstrating that the autoregulation of the cerebral blood flow is preserved.[21]

Although OH is common in those who are tetraplegic, it does not appear in every such individual. One may wonder why: An answer could be that incomplete lesions of the autonomic nervous system may exist, similar to incomplete motor and sensory lesions but we do not have the means of detecting these clinically. This is despite early twentieth century studies, in particular those of Dejerine on the systematization of the autonomic nervous system[22] and in the studies of André Thomas on the pilomotor reflex,[23] including studies during the phase of spinal cord automatism.[24] More recently Bonica has published an important work on the systematization of the nervous system and particularly of the autonomic nervous system.[25]

There is the possibility of interesting research, both clinical, based on these studies and those on autonomic evoked potentials to establish a protocol of autonomic nervous system examination; and secondly, anatomical-physiological, which would compare the protocol by fine detail imaging of the anatomical lesion.

The autonomic lesion level could also be defined by micrographic recordings of sympathetic activity by means of skin electrodes placed over a branch of the peroneal nerve,[26] and trials to determine the completeness or incompleteness of autonomic function have been conducted by registering potentials at the level of the soles of the feet in response to stimulation of the head.[27,28]

The situation might be clearer if there were longitudinal studies of orthostatic hypotension in tetraplegic individuals over a sufficient number of years. Lastly, it would be interesting to establish a collaboration with space medicine to detect and combat the effects of weightlessness, which necessitates the use of a pressurized space suit to compensate the lack of barometric pressure.

As publications are not only aimed at the self-gratification of their authors but also to help patients, I would like to bring up some points with regards to long-term life problems. Indeed, with the ageing process, the known difficulties increase and some others will appear.

OH and changes of position

Except in those individuals when tilting triggers off strong spasms which help the venous return,[29] tilting upwards usually causes a more unpleasant OH than does the change to a sitting position probably due to the fact that the internal organs are more compressed and that a person who is tetraplegic can lean forwards somewhat when sitting.

The change from lying prone to lying on the side and vice versa can also cause fainting. This phenomenon may be connected to hypovolemia, but this does not yet appear to have been proven.

OH and physical exertion

In the early stages of rehabilitation, it is advisable to perform rehabilitation exercises in a lying position before gradually adapting to the sitting position. With persistent training the achievements possible are sometimes quite amazing especially concerning the field of sports. The adaptation period is longer if to the neurological OH is added the loss of cardiac adaptation to exertion which is related to myocardial atrophy caused by prolonged immobilisation. Hence the importance of performing exercises in bed during the initial period and avoiding prolonged periods in bed later in life. Whenever possible, a period of sitting is beneficial.

Sooner or later, the ageing process can interfere with the adaptation to exertion, causing functional losses in dressing, transferring and moving which may even require a return to longer resting periods in bed.

OH and medications

There are few medications which can alleviate OH. Ephedrine has a limited effect and is frequently not tolerated. The benefits of Midodrine (Gutron) (r) have not been sufficiently proven.

Most of the medications which increase or cause OH are well known and include practically all of the antidepressants, sedatives, anaesthetics and antispasmodic drugs. The list is long and a small dose can suffice. But the tetraplegic person must be aware, when seeing his general practitioner, that morning fatigue due to OH can be mistaken for a symptom of depression and thus antidepressants may be wrongly prescribed.

A special mention must be made here of intrathecal Baclofen (r): several hundred pumps have been fitted to date including patients with lesions above T6 level. Although Baclofen (r), which lowers or suppresses muscle tone, also has a hypotensive as well as a respiratory depressant effect, there have not been, to our knowledge, any studies on the secondary effects, or even a mention of such effects in the manufacturer's instructions. Furthermore the users must be warned of the possible suppressant effect regarding erection and ejaculation.[30]

A 24 h blood pressure monitoring, as well as respiratory function tests, should be performed before and after the initial installation of the pump. The dosage and the mode of administration of the product should only be adjusted after careful examinations, certainly in aged patients with lesions above T6 level.

OH and surrounding temperature

Exposure to heat often makes OH worse and the impaired thermal regulation associated with problems of blood pressure regulation delay the perception of modifications in body temperature. Adaptation to heat includes perspiratory mechanisms and the activation of the thermo-regulating perspiratory glands which are under the influence of the sympathetic nervous system.

Methods of prevention (ventilator, air-fans and air-conditioner) and of intervention are well-known: wrist immersion in cold water and even better, repeated spraying of the trunk and upper limbs with water and if necessary the whole body.

Obviously, the excess temperature of the surroundings is better tolerated if the individual is in the lying position. The bath temperature has to be checked and ideally immersion should be in water at about 36–36.5°C.

Lastly, it may be worthwhile comparing some studies with those who have sustained severe burns suppressing a major number of skin receptors.

OH and the intestinal functions

It is well-known that the mesenteric circulation is normally greatly increased during digestion. Is the

haemodynamic mobilisation thus caused by the increase in intra-abdominal blood volume sufficient to explain OH? The mechanism has not yet been sufficiently explained.[12]

When a tetraplegic person suffers from post-prandial hypotension the best advice for such an individual is to lie down for an hour after a meal. Defecation can also cause hypotension when it necessitates a strong push against the closed glottis (Valsalva manoeuver). OH will be worse if the defecation triggers, as a result of anal spasticity, a small transitory hypertensive episode which is always followed by a hypotensive reaction.

OH and the urinary function

The tetraplegic person must be informed about the risks incurred by urinary retention not only because of hypertension but also because of the cardio-vascular collapse brought on by rapid emptying of the bladder.

OH and respiratory insufficiency

We do not know if there is a direct link between the two, OH and respiratory insufficiency, but we do know that their effects combine in diminishing functional performances and activities.

Knowing that those who are tetraplegic with a complete lesion have paralysis of the abdominal, intercostal and some other respiratory muscles (depending on the level of the lesion), as well as, at times, possible thoracic retraction due to the lack of thoracic mobilisation in the acute and post acute phase, and knowing that the vital capacity in all humans diminishes progressively during the whole of life from the beginning of adulthood, respiratory function tests as well as 24 h blood pressure monitoring should be a part of the regular follow-up of every person who is tetraplegic. This would help to prevent infectious and mechanical pulmonary complications such as bronchitis, pneumonia and atelectasis, by, for example, signalling the need for more chest physiotherapy, a reduction in activity and the setting up of ventilatory assistance at home.

Therefore, we can see that the conditions of life for someone who is tetraplegic do not solely depend on the extent of sensory and motor deficit, completeness or level of the lesion but also on the extent of the autonomic nervous system lesion. For hypotension, simple solutions such as support stockings, a multi-position reclining electric wheelchair, coffee intake,[31] restricted consumption of alcoholic drinks, and of hydrocarbonated food,[32] high salt diet for hyponatremia and a corset, are not always sufficient (corsets are sometimes difficult to adjust as they should not restrict the breathing and should take into account abdominal distension which can vary from day to day).

To conclude: The success of long-term rehabilitation depends to a great extent on a healthy lifestyle, on the knowledge acquired during rehabilitation, on the ability and willingness to be in charge of one's life, and on the quality of support in the family community. It depends finally on the financial situation of each individual who is tetraplegic as he or she becomes more and more dependent. The management of the various aspects of care (skin, bladder, bowels, blood pressure, and breathing) incur inevitably round-the-clock attendance which is costly.

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