A Study of Renal Function in Orthostatic Hypotension

By Erling Kruse Brodwall, M.D.

In orthostatic hypotension a considerable fall in blood pressure and cardiac output occurs in the erect position. There is an idiopathic form, most frequent in males 40 to 70 years of age. Further, there are symptomatic forms perhaps most frequently found in diabetes with neurologic disturbances.

Studies of renal function in orthostatic hypotension revealed decreased urine secretion in the erect position. There were falls both in renal plasma flow and in glomerular filtration rate when subjects with orthostatic hypotension were tilted into oblique position. Brunn and associates and Werkö et al. found even in subjects without orthostatic hypotension a fall both in plasma flow and in glomerular filtration rate during tilting. It is therefore difficult to determine whether these changes in renal function in orthostatic hypotension are due to the fall in blood pressure or are caused by other changes consequent to the altered position.

In subjects without orthostatic hypotension, Werkö’s group found no difference between the extraction of paraamino hippuric acid in the recumbent and tilted positions. No studies appear to have been made on the extraction ratio in orthostatic hypotension. The special purpose of this study is to determine whether there is any fall in the extraction ratio during the hypotensive phase in subjects with orthostatic hypotension.

Material and Methods

Two cases have been studied. O.S. (no. 1, table 1) was a 50-year-old man with idiopathic orthostatic hypotension who for about 10 years had suffered syncopeal tendencies in the standing position. In the recumbent position the blood pressure was approximately 125/80 mm. Hg, falling in the standing position to approximately 50/30 mm. Hg. There was no change in pulse rate on change of position.

M.S. (no. 2, table 1) was a 60-year-old man with the symptomatic type of orthostatic hypotension. He had suffered from diabetes for 2 years. During the last 12 months he had been troubled by syncopeal attacks in the standing position and signs of polyneuritis. The blood pressure was approximately 120/80 mm. Hg in the recumbent position, falling in the standing position to approximately 60/40 mm. Hg and there was no concomitant change in the pulse rate.

The glomerular filtration rate (inulin-clearance) and the renal plasma flow (paraamino hippuric acid clearance) were measured in the recumbent position and after various degrees of tilting. Methodologically we followed the description of Goldring and Chasis. The extraction ratios were obtained by catheterization of the right renal vein. The subjects were studied in the postabsorptive state. Values for glomerular filtration rate and renal plasma flow have been corrected to a body surface of 1.73 M².

Results and Discussion

The findings presented in table 1 show a fall both in plasma flow and in glomerular filtration rate. This, however, takes place only after a considerable fall in blood pressure and in the head-up oblique position of 25° and 30° respectively. There is no change in the extraction of paraamino hippuric acid in the hypotensive phase. This finding agrees with the observations of Van Slyke in experimental shock in dogs. He found decreased extraction of paraamino hippuric acid only after protracted and considerable shock and not until reduction of the plasma flow to below 10 per cent of control values. In our studies we did not try to obtain extreme falls in blood pressure as the consequent syncopeal tendency might conceivably cause extrarenal reactions which in turn might influence the renal function.

In case 2 we tried to keep the blood pressure unchanged on a low level during the second and third period, partly in order to determine the influence of positional changes alone, and partly to see whether the renal function was
stable during a fairly long period of unchanged low blood pressure. We did not succeed, however, in varying the oblique position to any notable degree without a simultaneous change in blood pressure.

The values in the third period, beginning after 20 minutes in the oblique position and covering 18 minutes, may indicate a return to normal of the renal function. It is not, however, justifiable to draw any definite conclusion on the basis of only 1 observation, and further study of the subject is required. We found no change in the filtration fraction in the hypotensive phase. Thus our results do not agree with the observations by Coreoran and associates,¹ who found a greater filtration fraction in the hypotensive phase. They presumed this increase in the filtration fraction to be caused by dilatation of the vasa afferentia.

The observations of Brun et al.³ and Werkö et al.⁴ indicate that in subjects without orthostatic hypotension there is a significant increase in the filtration fraction in the oblique position. This was considered to be a consequence of a constriction of the vasa efferentia. If our observations can be confirmed, it would mean that in orthostatic hypotension no regulating constriction by the vasa efferentia takes place in standing position after a fall in blood pressure. This is moreover likely, since there is a reduced ability to vasoconstriction in this condition.

**Summary**

Renal function studies have been carried out in both the recumbent and in the oblique position in 2 cases of orthostatic hypotension. In both cases a definite fall in plasma flow and glomerular filtration rate took place, but this occurred only after registration of a considerable fall in blood pressure.

The filtration fraction remains unchanged after the fall in blood pressure. The extraction ratio remains unchanged after a considerable fall in blood pressure.

The data may indicate that the renal function becomes normal if blood pressure is kept on a low level over a fairly long period. However, further observations are required before any definite conclusion may be drawn.

**Summario in Interlingua**

Studios del function renal esseva effectuate in position supin e oblique in 2 casos de hypotension orthostatic. In ambe casos un definite reduction del fluxo de plasma e del intensitate de filtration glomerular occurretva, sed solmente post que un considerabile reduction del tension de sanguine habeva esseite registrare.

Le fraction de filtration remane inalterate post le reduction del tension de sanguine. Le proportion de extraction remane inalterate post un considerabile reduction del tension de sanguine.

Le datos indica possibilemente que le function renal deveni normal si le tension de sanguine es mantenite

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### Table 1

**Renal Function in Two Cases of Orthostatic Hypotension**

<table>
<thead>
<tr>
<th>Case</th>
<th>Observation</th>
<th>Feature of Obl.</th>
<th>Blood Pressure</th>
<th>Effective Plasma Flow ml/min.</th>
<th>Total Renal Flow ml/min.</th>
<th>Glomerular Filtration Rate ml/min.</th>
<th>Effective Filtration Fraction</th>
<th>&quot;True&quot; Filtration Fraction</th>
<th>Extraction Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. O. S.</td>
<td>1</td>
<td>0</td>
<td>105/70</td>
<td>354</td>
<td>514</td>
<td>69</td>
<td>0.20</td>
<td>0.14</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>15°</td>
<td>100/65</td>
<td>341</td>
<td>515</td>
<td>62</td>
<td>0.18</td>
<td>0.12</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>25°</td>
<td>70/50</td>
<td>358</td>
<td>580</td>
<td>66</td>
<td>0.17</td>
<td>0.11</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>30°</td>
<td>70-60/40-30</td>
<td>293</td>
<td>425</td>
<td>54</td>
<td>0.19</td>
<td>0.13</td>
<td>0.68</td>
</tr>
<tr>
<td>2. M. S.</td>
<td>1</td>
<td>0</td>
<td>115/80</td>
<td>560</td>
<td>608</td>
<td>88</td>
<td>0.16</td>
<td>0.14</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>25°</td>
<td>85/60</td>
<td>460</td>
<td>480</td>
<td>63</td>
<td>0.14</td>
<td>0.13</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>20-25°</td>
<td>85/60</td>
<td>580</td>
<td>586</td>
<td>79</td>
<td>0.16</td>
<td>0.13</td>
<td>0.99</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0</td>
<td>110/85</td>
<td>645</td>
<td>695</td>
<td>85</td>
<td>0.13</td>
<td>0.12</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Effective filtration fraction: Glomerular filtration rate
"True" filtration fraction: Effective renal plasma flow

**"True" Filtration Fraction** = Glomerular filtration rate / Total renal plasma flow

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*Circulation, Volume XXI, January 1960*
a un base livello durante un satis longe periodo de tempore. Tamen, observationes additional es requirite antequem un conclusion definitivae poter eser formulate.

References

Michael Servetus

In Spain, in the land where above all other places the Church and the Inquisition were stifling inquiry, in Villannueva in Aragon, there was born in 1511 a man, afterwards known by the name of Michael Servetus. Fleeing early from the Inquisition and his native soil, wandering in many lands, studying many things, learning anatomy under Sylvius and Günther at Paris, where he might have sat perhaps on the same bench with Vesalius, his active mind devoured all the knowledge of the time. He was in turn jurist, astronomer, meteorologist, geographer and doctor, but above all other things, a theologian. He threw himself with zeal into medical studies, and acquired in them such a reputation that the Archbishop of Vienna made him his physician; but his real interest in such studies lay in his belief that the study of anatomy was one of the paths which lead to a knowledge of God. To know, said he, the spirit of God, we must know the spirit of man; and to truly know the spirit of man, we must know the structure and working of the body in which that spirit resides. This led him to introduce anatomical disquisitions into his theological works. . . .

Everyone knows how in 1553, on Oct. 27, he was burnt at the stake in Geneva at the bidding of Calvin, because he would not recant his religious faith. With him, or at the same time, there was burnt the whole edition of 1000 copies of his book, the Restitutio, with the exception of some few copies which had passed into the hands of friends.—Sir M. Foster. Lectures on the History of Physiology. London, Cambridge University Press, 1901.
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doi: 10.1161/01.CIR.21.1.38
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0009-7322. Online ISSN: 1524-4539

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