Total body water and total body potassium in ileostomy patients before and after conversion to the continent ileostomy

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SUMMARY  Total body water (TBW) and total body potassium (TBK) were studied in 40 ileostomists before (with conventional ileostomy) and one year after conversion to a continent ileostomy. Each patient acted as his own control. Total body water was determined by using an isotope dilution technique and TBK by counting the gamma radiation from the naturally present nuclide 40K in a whole body counter. Measured values of TBW and TBK were compared intraindividually (conventional versus continent ileostomy) and also with ‘normal values’ obtained from the same laboratory and based on a multiple regression analysis of data from 476 healthy controls. There was no evidence of water or potassium depletion in ileostomy patients, neither before nor after construction of the continent ileostomy.

Proctocolectomy and construction of an ileostomy inevitably results in an increased faecal loss of fluid and electrolytes. Normal stools contain approximately 100 ml of water, whereas a well established normally functioning ileostomy discharges 5–600 ml/day. Thus, the implications with respect to water balance in these patients are obvious. Earlier studies in patients with conventional ileostomies have indicated a reduction in total body water which has been interpreted as a state of chronic dehydration.

The continent ileostomy, introduced by Kock in 1969, is established either primarily in connection with proctocolectomy or later as a conversion from a conventional ileostomy. Studies in continent ileostomy patients have shown an active net absorption of water and electrolytes from the pouch. The excretion of sodium and potassium in urine have shown values compatible with those of patients with conventional ileostomies. Indeed, the absorptive pattern in the conventional and the continent ileostomy patient is very similar. In a previous report from our departments a reduction in total body water could not be found in patients with continent ileostomies.

Total body potassium, which reflects the total body cell mass, did not differ from normal values in the afore mentioned study from our departments. In a recent study by Cooper et al., however, on body composition in 12 conventional ileostomy patients, a reduction in total body potassium was found.

Because of these conflicting results we decided to undertake a study of a larger number of patients scheduled for conversion of their conventional ileostomy to a continent ileostomy. The aims of the present study were to investigate total body water and total body potassium in patients before, and after, construction of the continent ileostomy. Furthermore, a comparison was made with reference values obtained from our laboratory.

Methods

Patients  Forty consecutive patients were studied, 18 women and 22 men, scheduled for construction of a continent ileostomy. The patients had had their conventional ileostomy for a median time of 4-5 years (range 1–16). The diagnoses were ulcerative colitis in 36 patients, Crohn’s disease in three and familial polyposis in one. The three patients with Crohn’s disease had all been subjected to proctocolectomy more than
Table 1  Body characteristics of 40 ileostomy patients (18 women, 22 men)

<table>
<thead>
<tr>
<th></th>
<th>Conventional ileostomy</th>
<th>Continent ileostomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>Age (years)</td>
<td>37 (9-4)</td>
<td>39 (8-4)</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>60 (4-6)</td>
<td>62 (5-9)</td>
</tr>
<tr>
<td>Body height (cm)</td>
<td>165 (5-9)</td>
<td>178 (5-3)</td>
</tr>
</tbody>
</table>

Values: mean (SD).

Table 2  Haematological and biochemical values before and after conversion to the continent ileostomy

<table>
<thead>
<tr>
<th></th>
<th>Conventional ileostomy</th>
<th>Continent ileostomy</th>
<th>Reference values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>ileostomy</td>
<td>ileostomy</td>
</tr>
<tr>
<td>Haemoglobin (g/l)</td>
<td>40</td>
<td>143-3 (13-8)</td>
<td>144-4 (16-4)</td>
</tr>
<tr>
<td>Serum albumin (g/l)</td>
<td>40</td>
<td>42-3 (3-4)</td>
<td>42-3 (3-2)</td>
</tr>
<tr>
<td>Serum Na+ (mmol/l)</td>
<td>40</td>
<td>139-7 (2-0)</td>
<td>139-3 (2-1)</td>
</tr>
<tr>
<td>Urine Na+ (mmol/24h)</td>
<td>31</td>
<td>69 (33-3)</td>
<td>74 (44-4)</td>
</tr>
<tr>
<td>Serum creatinine (µmol/l)</td>
<td>40</td>
<td>89-2 (13-3)</td>
<td>88-4 (13-3)</td>
</tr>
</tbody>
</table>

Values: mean (SD)

five years before the investigation and had no signs of small bowel inflammatory disease. None of the patients had had a small bowel resection of more than 10 cm. All patients were studied twice; at the first occasion, when having a conventional ileostomy and then a second time one year after conversion to the continent ileostomy. In this way each patient acted as his own control, making an intraindividual comparison possible. The mean age, body weight, and height at the time of the investigations are designated in Table 1.

All subjects were in good general health at the time of both investigations and the haematological and biochemical values were similar at both examinations as indicated in Table 2. All values were within the normal range, except for haemoglobin in one woman with a conventional ileostomy and in another with a continent ileostomy. The urinary output of sodium was below 50 mmol/24 h in three patients with a conventional ileostomy and, in addition, there were another two patients with low urinary sodium output after conversion to a continent ileostomy.

PROCEDURES

Total body water (TBW) was determined with an isotope dilution technique using tritiated water as a tracer. The subjects were given by mouth 100 µCi tritiated water dispensed in half a glass of water. After equilibration for two hours, a plasma sample was taken and analysed in a liquid scintillator counter (Tricarb, Packard Instrument Co). Total body water was calculated from the formula

\[
\text{TBW} = \frac{\text{total counts of tritium administered}}{\text{counts per litre of serum}}
\]

The total expected standard deviation of a single total body water determination was ±3.2%. Measurements carried out on the ileostomy discharge have shown a specific activity of tritiated water of the same value as in plasma.

Total body potassium (TBK) was determined by measuring the gamma radiation from the naturally present radionuclide 40K. The measurement was done in a high sensitivity 3π whole body counter containing four large plastic scintillators with a total volume of 700 dm³. The shield consists of a room made of iron with walls 15 cm thick and lined on the inside with 3 mm of lead. The total expected standard deviation of a single potassium determination was ±2.4%. Because of technical problem (contamination by 24Na) it was only possible to obtain correct values of TBK in the first 20 patients measured.

Reference values were derived by multiple regression analysis of data from 476 healthy subjects obtained in the same laboratory as in the present study. Normal values of TBW and TBK were predicted by knowing the body weight, body height, sex and age of the subject. The following formulas were derived:

For men: TBK=27.3 BW+11.5 BH−21.9 age+778 (314 mmol) and TBW=0.40 BW+0.023 BH−0.056 age+12.1 (3.5 l). For women; TBK=16.7 BW+16.7 BH−7.9 AGE−821 (275 mmol) and TBW=0.24 BW+0.20 BH−0.03 age−13.9 (2.8 l). (SE).

Results

**TOTAL BODY WATER (TBW)**

Measured values of TBW for each subject while
having a conventional ileostomy and after construction of the continent ileostomy, are illustrated in Figure 1. Mean values (SD) for conventional and continent ileostomists and the corresponding predicted values are presented in Table 3. When the difference between the two observed values (conventional – continent ileostomy) of each subject was calculated, it resulted in a mean difference for all patients of 0.8 (0.6) litre (mean SE)), the resulting 95% confidence interval being −0.3 to 1.91.

To make a comparison between observed and predicted values possible, the deviation expressed as a percentage of predicted values was calculated for conventional as well as continent ileostomies. Mean difference for conventional ileostomists was 3.0 (1.4) (SE)% and for continent ileostomists 2.2 (1.5) (SE)% The resulting 95% confidence limits being 0.3 to 5.7% and −0.8 to 5.2%, for conventional and continent ileostomies respectively.

Table 3 Values of TWB (l) and TBK (mmol) for conventional and continent ileostomists. For TBW measurements *n*=40 (18 women, 22 men), for TBK measurements *n*=20 (10 women, 10 men)

<table>
<thead>
<tr>
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<th>Conventional ileostomy</th>
<th>Continent ileostomy</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>Observed TBW</td>
<td>33.1 (4.8)</td>
<td>48.5 (4.4)</td>
</tr>
<tr>
<td>Predicted TBW</td>
<td>32.9 (2.2)</td>
<td>46.3 (2.7)</td>
</tr>
<tr>
<td>Observed TBK</td>
<td>2716 (462)</td>
<td>4719 (390)</td>
</tr>
<tr>
<td>Predicted TBK</td>
<td>2658 (182)</td>
<td>4172 (246)</td>
</tr>
</tbody>
</table>

Values: mean (SD)

**Discussion**

In the present study data are presented on total body water and total body potassium for 40 ileostomy patients. All patients were studied twice; before and one year after conversion to the continent ileostomy. Each patient thus served as his own control. Our results indicate that there is no reduction in TBW or TBK in patients with either type of ileostomy. The methods used here have been used for many years in our laboratory and have proved to be valuable and reliable in clinical practice.

Earlier results on TBW measurements reported in the literature for ileostomy patients have been conflicting. Hill et al. have presented data on patients with conventional ileostomies indicating a mean deficit in total body water of 11%. This was, however, not confirmed by Cooper et al., who found that ileostomy patients were not dehydrated. Nilsson et al. likewise found no difference between normal values and values in patients with continent ileostomies. All these studies include a rather small number of patients compared with our study group which, furthermore, was measured twice, with a conventional and a continent ileostomy. Thus, a direct comparison was possible between measured values in each patient with either type of ileostomy. We found no difference between the two groups, indicating that the type of ileostomy does not influence water balance. When a comparison was made between observed and predicted values, the resulting 95% confidence interval was narrow and very similar for conventional and continent ileostomy patients. This supports the results found by Nilsson et al. and Cooper et al. In the study by Hill et al. only 10 patients were studied. Moreover, half of the patients had had an ileal resection which might have influenced the results. Finally, the predicted values obtained in the Hill study were based on TBK.
Total body water and total body potassium in ileostomy patients

measurements in 22 male subjects. Our sample is much larger and results in a narrow 95% confidence interval suggesting that the 11% deficit earlier stated by Hill is probably not correct. Our results indicate that the difference from normal values, if any, is likely to be within the interval of −0·8 to 5·7%. Because we consider this figure to be outside the bounds of clinical significance, we conclude that there is no water depletion in healthy ileostomy (conventional or continent) patients.

Total body potassium reflects the body cell mass and thus the nutritional status. The results in the present study where no difference was found between measured values before and after conversion to the continent ileostomy indicate that this procedure does not affect body cell mass. Moreover, measured values of TBK in patients with conventional and continent ileostomies corresponded well to predicted values. This is in accordance with the study of Nilsson et al but contrary to the results of Cooper et al who found a reduction in TBK in patients with conventional ileostomies. Cooper and coworkers used the same methodology as ourselves to measure TBK and found a reduced TBK in ileostomy patients which they attributed to a reduction of fat free mass. There is no obvious explanation for the difference in our findings. Evidently there is a large discrepancy between the English and Swedish populations because predicted values differ considerably. In addition, predictive values were calculated in two different ways. In the work by Cooper et al, the prediction was based on sex, age, and height while we have included weight as a fourth factor. If our data were recalculated, however, and based on a prediction excluding weight, there is still no difference between measured and predicted values. Patient data also indicate that two quite different groups of ileostomy patients have been presented, and this may be the determinant for the dissimilar results. Malnutrition among the English ileostomists seems to be one possible explanation.

In conclusion, our results revealed no difference between conventional and continent ileostomy patients in total body water and total body potassium. Furthermore, when compared with normal (predicted) values no reduction in TBW and TBK was seen in patients with either type of ileostomy.

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References

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