SPA THERAPY IN UROLOGICAL DISEASES.

Dr. med. Christoph GUTENBRUNNER

Universität Marburg
West Germany

Christoph Gutenbrunner, Institut für Arbeitsphysiologie und Rehabilitationsforschung der Universität Marburg/Lahn and Institut für Kurmedizinische Forschung Bad Wildungen.

In Germany for patients suffering from urological diseases, e.g. renal stone formation and urinary tract infections, drinking cures with natural mineral waters are on the one hand applied within the scope of a complex balneological treatment, on the other hand are used for house drinking cures e.g. for the prophylaxis of urolithiasis (see also GUTENBRUNNER 1986). In the following I will give a short survey of our recent investigations concerning the effect of isolated and combined drinking cures on the urinary composition and the bladder function.

The risk of renal stone formation depends among others on the urinary composition, especially on the relation of stone forming and inhibitory substances (ROBERTSON and PEACOCK 1985; and others). Concerning the therapeutical effects of mineral water drinking the micromolecular lithogenic and inhibitory substances are of special interest. The most important lithogenic substances are calcium, oxalate, phosphate and uric acid. As inhibitory substances magnesium and citrate have to be considered. The urinary excretion of these substances are not only influenced by nutritional and individual factors, but also by rhythmic changes of renal functions, e.g. circadian and circannual rhythms. The urinary pH is controlled by these spontaneous rhythms as well.

In a first study we measured the renal oxalate excretion in healthy test persons after intake of a standardized oxalate-rich meal. The nutrient intake was standardized starting with the breakfast at 8.00 a.m. Urinary samples were collected in two hour intervals. At 12.00 a.m. an oxalate-rich meal was administered consisting of 220 g spinach with potatoes and 125 g rhubarb (total oxalate: 680 mg). Additionally 500 ml of different calcium-containing mineral waters or tap water respectively were applied. Each test person had to pass through three of these experiments with different test fluids in order to enable intraindividual comparisons. In the four hours after the meal urine samples were collected in 1-hour-intervals. In all urine probes the concentrations of oxalate, citrate, calcium and magnesium were measured.

In Fig. 1 the mean oxalate excretion after intake of tap water and different cal-
Spa Therapy in Urological Diseases.

cium-containing mineral waters is demonstrated. In both test series the oxalate excretion was significantly lower after the intake of the calcium-containing mineral waters in comparison with the tap water controls (GUTENBRUNNER et al. 1988). These results show that the calcium supply by mineral waters may lead to an intestinal binding of the nutritional oxalate, lowering the stone forming risk caused by dietary lapses (cf. FUTTERLIEB et al. 1985).

In another series of experiments we investigated the influence of mineral waters on the circadian rhythm of the urine excretion. This physiological variation consists in a nightly retention and increase of urinary density. It is not only caused by the discontinuity of fluid intake and physical activity, however, is also detectable under constant bed rest and equally distributed food and fluid intake (Fig. 2). The nightly retention increases the risk of stone formation and therefore is of special interest in respect to the prophylaxis of renal stones (VAHLENSIECK et al. 1982).

The design of the diurnal experiments was standardized, however, the applied test-fluids were changed. The healthy male test persons had to stay for 24 hours in a climatic chamber under constant bed rest. A standardized diet with low protein and calcium content was administered in 4-hour intervals throughout the 24 hours of the experiment. The test fluids were given in three portions: 700 ml at 9.00 a.m., 350 ml at 1.00 and 5.00 p.m. The respective test fluids were also administered two days before the 24-hour-experiment. The urine was collected during 24 hours in 6 4-hour probes. Besides urinary volum, pH, and osmolarity the concentrations of sodium, calcium, oxalate, phosphate, sulphate, magnesium and citrate were measured. The experiments were repeated with the same test-persons and different test fluids to enable intraindividual comparisons.

In Fig. 3 the effect of sodium-containing waters on the urinary volume is demonstrated. The upper curve represents the mean course of the urinary volume after intake of tap water. All curves are plotted twice in order to gain a better survey. The mean change of the urinary volume after the intake of a sodium-rich mineral water is plotted. After the first two drinking portions the urinary volume is reduced according to the retentive effect of sodium. However, during the following 16 hours, the urinary volume is increased, what leads to positive correlation between sodium content of the test fluid and the nightly urinary volume (GUTENBRUNNER 1988).

This delay of the urine excretion causes a flattening of the circadian rhythm of the diuresis (Fig. 4), resulting in a decrease of the risk of nightly stone formation (HILDEBRANDT et al. 1983).

In respect to the risk of stone formation the calcium-content of mineral waters is discussed controversially. However, it has to be considered, that most mineral waters used for therapeutic purposes also contain other electrolytes, e.g. sodium, hydrogen carbonate or magnesium. So we compared the urinary concentrations of stone-forming and inhibitory substances after the intake of an urological mineral water with the tap water controls (GUTENBRUNNER 1988; GUTENBRUNNER et al. 1988). The respective mineral water contained about 300 mg of calcium, 225 mg of magnesium and about 3,000 mg of hydrogen carbonate. Fig. 5 shows, that besides the calcium-concentration the concentrations of citrate and magnesium are increased, the latter especially during the night. As the lowest curve shows, the cal-
Fig. 1 Mean urinary oxalate excretion of healthy test persons during four hours after a standardized oxalate-rich test meal with additional intake of 500 ml of natural mineral waters or tap water respectively. The brackets indicate standard errors.

Fig. 2 Mean 24-hour-courses of the urinary volume, the urinary pH and the urinary concentrations of calcium, magnesium, uric acid and phosphate in 10 healthy subjects under equally distributed food and fluid intake. The brackets indicate standard errors.
Fig. 3  Mean 24-hour-courses of the urinary volume after tap water intake, of the mean change of the urinary volume after intake of a sodium-containing natural mineral water and of the correlation-coefficient between the sodium-content of the mineral waters and the urinary volume in healthy subjects under equally distributed food and fluid intake. The time points of the figure. For better survey the curves are plotted twice. The brackets indicate standard errors; * = p < 0.05. (From GUTENBRUNNER 1988).

Fig. 4  Scheme of the circadian variations of the urinary volume without additional drinking, after additional intake of tap water or sodium containing mineral water respectively. (From HILDEBRANDT et al. 1983, modified).
Cium-oxalate crystallization risk index (Tiselius 1983) was not increased by the calcium-rich mineral water. In addition the correlative analysis of the data with regard to five different waters showed that especially a high concentration of sodiumbicarbonate and a low calcium-magnesium-proportion of the mineral waters are favourable to the prophylaxis of calcium-oxalate concrements (Gutenbrunner 1988). Most characteristic for the effect of balneological treatment is the evocation of adaptive processes which lead to a normalization of autonomous functions (Hildebrandt 1985). These functional-adaptive processes are periodically structured by a predominant circaseptan periodicity. In long-term experiments in healthy subjects we could show that even isolated mineral water cures can cause adaptive processes in which renal functions are involved.

The urinary volume and electrolyte excretion as well as the urinary pH showed a circaseptan periodicity during the treatment. This phenomenon was not seen in tap water controls (Hildebrandt et al. 1981, 1983). Moreover the immediate changes of the urinary composition (increase of the urinary pH and the excretion of electrolytes) were greater at the end of the cure. These adaptive changes were stable at least for two weeks after the end of the cure (Hildebrandt et al. 1982).

In order to study the effects of these adaptive modifications in renal function in patients suffering from recurrent urolithiasis, we performed a long term study in the course of complex cure treatment including drinking cures with a calcium-magnesium-bicarbonate water (Gutenbrunner et al. 1986). The nocturnal

Fig. 5 Mean 24-hour-courses of the urinary concentrations of calcium, magnesium and citrate in healthy subjects under equally distributed food and fluid intake and additional intake of tap water (open symbols) or a natural Na-Mg-Ca-HCO₃-Cl-water (filled symbols). The time points of the additional intake of the test fluids are marked on top of the figure. For better survey the curves are plotted twice. The brackets indicate standard errors. * = p < 0.05; ** = p < 0.01; *** = p < 0.001. (From Gutenbrunner 1988).
urine of 37 patients was collected daily during the 4-weeks cure treatment and examined for quantity and electrolyte composition. In order to obtain uninfluenced initial values and final values on the first and last two days of the cure no mineral water cure was performed.

As Fig. 6 shows, the urinary volume only revealed a transitory increase during the first week of the cure, whereas the mean concentrations of uric acid, phosphate and the calcium-magnesium-ratio significantly decreased, indicating a reduction of the risk of renal stone formation. However, the excretion of uric acid exhibited crisis-like short-time increases. The distribution of these peaks are shown in Fig. 7 (lower curve). It can be seen, that the frequency of these peaks shows a decreasing tendency according to the decrease of the mean uric acid concentration (Fig. 7, upper curve). However, the course is periodically structured, exhibiting maximum values around day 8 and in the third week of the cure. Together with the demonstrable normalization tendency of the values of the nightly uric acid concentration (GUTENBRUNNER et al. 1986), these results can be evaluated as reactive periods of metabolic or renal functions. Those reactive periods and normalization tendencies are typical for cure processes and can be interpreted as functional adaptation (see HILDEBRANDT 1985).

Micturition disturbancies exhibit another risk factor for the stone formation as well as of urinary infections. Because of the fact, that the voiding of the bladder is controlled by the autonomous nervous system changes in the micturition ability could be expected in the course of the functional adaptive changes evoked by the cure treatment. Therefore we performed in 38 patients close-meshed controls of the uroflow in the course of 4-weeks combined cure treatment, including drinking cures with a calcium-magnesium-bicarbonate water (GUTENBRUNNER & SCHWERTE 1988). The patients were investigated performing a spontaneous micturition during forenoon.

As Fig. 8 shows, the mean and maximum flow rate significantly increased in the course of the treatment, whereas the total voiding time decreased. The urinary volume was slightly increased as well. All curves additionally exhibited a periodic time structure, indicating a functional adaptive mechanism of the changes. The time at maximum flow showed no significant trend, however together with the higher maximum flow rate and the shorter voiding times, in conclusion a steeper increase of the uroflow can be assumed (GUTENBRUNNER & SCHWERTE 1988). These improvements of the uroflow values were correlated with a significant decrease of the cortisol excretion in the nightly urine, indicating a reduction of the sympathetic activity.

In order to detect normalization tendencies of the results of the uroflow measurements, we correlated individual initial values (day 3) with the respective linear trends in the following 24 days of cure. As Fig. 9 shows, the linear trend of the total voiding time and the maximum flow rate are significantly correlated with the initial values, indicating an increasing tendency of low values and a decreasing tendency of high initial values. The so-called cross-over point of this correlation, which is equivalent to the values which are not influenced by the treatment, coincide
Fig. 6 Mean courses of the urinary volume and the concentrations of uric acid and phosphate as well as the calcium-magnesium-ratio in the nightly urine in 37 patients suffering from recurrent urolithiasis undergoing a combined spa treatment including mineral water cures with a natural Ca-HCO₃-C1-CO₂-water. The brackets indicate standard errors. The solid lines represent linear regressions. (From GUTENBRUNNER et al. 1986).

Fig. 7 Mean courses of the uric acid concentration and of the frequency of values > 90mg% in the nightly urine in 37 patients suffering from recurrent urolithiasis undergoing a combined spa treatment including mineral water cures with a natural Ca-HCO₃-C1-CO₂-water. The brackets indicate standard errors. The solid lines represent linear regressions. (From GUTENBRUNNER et al. 1986).
Spa Therapy in Urological Diseases.

Fig. 8 Mean courses of the indicated uroflow-values in 36 patients undergoing a combined spa treatment. 17 patients suffered from an adenoma of the prostate. The brackets indicate standard errors. The solid lines represent linear regressions. (From GUTENBRUNNER & SCHWERTE 1988).

Fig. 9 Correlations between the initial values (day 3 of the treatment) and the linear trend (regression coefficient from day 4 to day 28) of the total voiding time and the maximum flow rate of 36 patients undergoing a combined spa treatment. The normal values from the literature are indicated on top of the respective part of the diagram. (From GUTENBRUNNER & SCHWERTE 1988).
in both cases with the normal values from the literature. Therefore it can be concluded, that the motoric bladder function underlies a significant normalization tendency in the course of the balneological treatment. The other parameters of the uroflow measurements exhibited normalization tendencies as well.

Altogether our results show that the combined balneological treatment as well as isolated drinking cures can improve the urinary composition and the bladder function. Therefore the tradition of urological cure treatment seems to be justified and its effects are evident and detectable using modern scientific methods.

References


Author'S address : Dr. med. Christoph Gutenbrunner, Institut für Arbeitsphysiologie und Rehabilitationsforschung der Universität Marburg/Lahn, Robert Koch-Str. 7a, D-3550 Marburg/Lahn Fed. Rep. Germany