Actual Ionized Calcium (at Actual pH) vs Adjusted Ionized Calcium (at pH 7.4) In Hemodialyzed Patients

To the Editor:

Ionized calcium is now the measurement of choice for evaluating calcium metabolic diseases (1, 2). Ionized calcium may be reported either as the actual ionized calcium, referred to the actual pH of the patients (arterial or capillary blood), or as adjusted ionized calcium, to a standard pH at pH 7.40. The latter has been shown to be as useful as actual ionized calcium in evaluating patients with chronic disorders of calcium metabolism (3). Although, theoretically, actual ionized calcium should be superior to measurement of adjusted ionized calcium in patients undergoing hemodialysis, because of the severe metabolic changes involved (3), studies showing this are lacking.

In a prospective study, we measured actual ionized calcium, adjusted ionized calcium, and parathyroid hormone (by Allegro Intact PTH; Nichols Diagnostic, San Juan Capistrano, CA) in 18 patients regularly undergoing hemodialysis. Blood samples were collected from the arteriovenous fistula in glass capillary tubes (Clinitubes™; Radiometer, Copenhagen, Denmark), before and after hemodialysis, for measurement of actual and adjusted ionized calcium at 37°C with a semiautomated ICA1™ analyzer (Radiometer) as previously described (4). The ICA1 calculated the concentration of adjusted ionized calcium from the measured ionized calcium and pH according to the slope for $\Delta \text{log} \sqrt{\text{Ca}^{2+}}/\Delta \text{pH}$, i.e., −0.23, which is the conversion factor used in all commercial analyzers and currently reflects the actual adjustment performed in the routine laboratory.

We observed a highly significant relationship between actual and adjusted ionized calcium ($r = 0.88, P < 0.0001$) but with a high residual variance across the regression line (Figure 1). The concentration of actual ionized calcium was increased in 27.8% and decreased in 16.6% of the samples, compared with 58.4% and 13.9%, respectively, for the concentrations of adjusted ionized calcium, corresponding to a diagnostic discrepancy between the two methods of 44.4%. In our study, the major factors responsible for the difference between actual and adjusted ionized calcium are probably the rapid changes in acid–base (from pH 7.37 to 7.46; mean values pre- and postdialysis), albumin (from 623 to 696 μmol/L), phosphate (from 2.06 to 1.04 mmol/L), and other anions such as lactate and free fatty acids (not measured). The adjusted ionized calcium, which is based on in vitro respiratory changes (i.e., CO2 loss), does not take the above-mentioned factors into consideration, which may therefore explain the high discrepancy between the two variables.

During dialysis, the actual ionized calcium increased in all patients (from mean 1.22 to 1.42 mmol/L) except one (pre- and postdialysis hyperparathyroid); postdialysis, 55% of the patients had values within the reference interval, compared with 6%, as judged by the value for adjusted ionized calcium. The patients showed an average decrease in parathyroid hormone of 53% (range 11%–79%); however, 52% of the patients remained hyperparathyroid postdialysis. This observation suggests that it might be clinically appropriate to increase the amount of actual ionized calcium in serum by using calcium supplement or calcitriol treatment, to achieve normal values for parathyroid hormone and thereby decrease the reabsorption of calcium from bones. However, this idea needs to be substantiated by a much larger clinical study.

We conclude that measurement of actual ionized calcium is preferable in patients undergoing hemodialysis, whereas adjusted ionized calcium is inappropriate because of the rapid changes in pH, albumin, phosphate, and other anions taking place in such patients.

References


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Atypical Electrophoretic and Isoelectrophoretic Patterns of Neutrophil Alkaline Phosphatase in a Case of Subacute Myelomonocytic Leukemia

To the Editor:

Reports of variations of alkaline phosphatase (AP; EC 3.1.3.1) isoenzymes in hematopoietic tumors and