Effects of Normal and Abnormal Urine on Red Cell Shape

L.O.

Simpson

Department of General Practice, Medical School, Dunedin, New Zealand

Dr. L.O. Simpson, Department of General Practice, PO Box 913, Dunedin (New Zealand)

Dear Sir,

Several authors have claimed that on the basis of the shape of urinary red cells, they can determine that the cells are or are not of glomerular origin [1,2]. In view of the number of such reports and because of the known differences between plasma and urine in terms of solute concentration, ionic composition and pH, it is surprising that there are no studies which have examined the possibility that the urinary environment alone might influence red cell shape. This letter describes a simple study in which the time-related changes in red cell shape which occurred after blood was mixed with urine have been quantified.

Urine samples assessed as normal; light proteinuria, 0.3 g/l; light proteinuria with hematuria, 0.3 g/l plus 7×10^3 red cells/ml; heavy proteinuria with hematuria, 3.0 g/l plus 10×10^3 red cells/ml; and glycosuria 5.5 mol/l were obtained in fresh condition after they had been assessed in the Dunedin Hospital Chemical Pathology Laboratory. Aliquots of well-shaken urine (5 ml) were placed in plastic tubes, and 0.5 ml of freshly drawn blood from a healthy subject was added to each tube after 3 drops had been dripped into 5 ml of a 2.5% solution of glutaraldehyde in 0.1 M cacodylate buffer at pH 7.4 as a baseline sample. Duplicated 3-drop samples of the blood-urine mixture were added to 5 ml of the glutaraldehyde fixative at the following times after mixing: 30 s, 2, 4, 8, 16, 32, 60 and 90 min.

Samples were randomised, given a serial number and allowed to fix overnight.

Blood samples were processed as previously described [3] and the cells classified and counted. When all samples had been assessed, the code was broken and the average values of the duplicate samples were used to quantify the changes in red cell shape.

Glycosuric urine had a more dramatic effect on erythrocyte shape than the other urine samples. After 2 min, there were more than 90% spherocytocytes, and by 90 min, 99% of erythrocytes had assumed this form as shown in figure 1 row e. Normal urine and urine with light proteinuria induced similar changes in cell shape, as shown in figure 1 rows a and b, and the percentages of crenated and spiculed cells were similar also. With time passing, there was a reduction in the percentages of spiculed cells with a comparable increase in crenated cells. Hematuria, whether associated with heavy or light proteinuria, was accompanied by a more intense specculation (fig. 1 rows c, d), and by 2 min, more than 80% of erythrocytes were transformed into spiculed cells.

Urine samples from normal subjects contained dysmorphic red cells [1,4] which shows that renal pathology is not necessary for hematuria. As urinary red cells were increased by strenuous exercise [5], it is possible that urinary red cell numbers are determined by the same factors which can account for exer-

cise-induced proteinuria, i.e., increased in-traglomerular pressure and basement membrane thixotropy [6]. Ohsaka et al. [7] showed that when intracapillary pressure was increased greatly, red cells were extruded between endothelial cells.

This simple study shows that normal erythrocytes respond to a urinary environment by echinocytic transformation, the nature and extent of which appears to be determined by the characteristics of the urine. It seems reasonable to suggest that erythrocytes from the abnormal environment due to renal dysfunction might respond differently. Whatever factors are responsible for urinary red cell 'dysmorphism', it is clear that the urinary environment is an important factor.

©1992 S.Karger AG, Basel
0028-2766/92/
0603-0383\$2.75/0

Fig. 1. Micrographs showing the red cell shape changes which occurred in the urine-blood mixtures between 2 and 90 min. a Effects of normal urine, b Light proteinuria. c Changes in hematuric light proteinuria. d Changes are similar to those in c and are caused by hematuric heavy proteinuria. e Effects of glycosuria. Column 1: samples taken after 2 min; column 2: samples taken after 8 min; column 3: samples taken at 32 min; column 4: samples taken after 90 min. $\times 2,000$.

References

Birch, D.F.; Fairley, K.F.; Whitworth, J.A.; Forbes, I.K.; Fairley, J.K.; Cheshire, G.R.; Ryan, G.B.: Urinary erythrocyte morphology in the diagnosis of glomerular hematuria. *Clin. Nephrol.* 20:78-84(1983).

Rizzoni, G.; Braggion, F.; Zachello, G.: Evaluation of glomerular and nonglomerular hematuria by phase contrast microscopy. *J. Pediatr.* 103: 370-374 (1983).

Simpson, L.O.: Blood from healthy animals and humans contains nondiscocytic erythrocytes. *Br. J. Haematol.* 73:561-564 (1989).

Loh, E.H.; Keng, V.W.; Ward, P.B.: Blood cells and red cell morphology in the urine of healthy children. *Clin. Nephrol.* 34:185-187 (1990).

Gibbs, D.D.; Lynn, K.L.: Red cell volume distribution curves in the diagnosis of glomerular and nonglomerular hematuria. *Clin. Nephrol.* 55:143-147(1990).

Simpson, L.O.: Glomerular basement membrane thixotropy and proteinuria; in Lubec, G. and Hudson B.G. (eds.): *Glomerular Basement Membrane*, pp. 49-58 (John Libbey, London 1985).

Ohsaka, A.; Suzuki, K.; Ohashi, M.: The spurting of erythrocytes through junctions of the vascular endothelium treated with snake venom. *Microvasc. Res.* 70:208-213 (1975).