PAPERS AND SHORT REPORTS

Urinary red-cell morphology during exercise

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Abstract

Midstream urine samples were examined by phase-contrast microscopy before and immediately after 48 subjects participated in a long-distance run. Minor abnormalities were found in six samples before exercise. Eighteen subjects developed proteinuria and five haematuria on dipstick testing after exercise. Forty-four subjects had increased urinary red-cell counts after exercise; of these, 33 had counts above the normal range (8000/ml). In all subjects urinary red cells were dysmorphic both before and after exercise, indicating a glomerular source. Ten subjects developed red-cell casts and 42 showed an increase in hyaline and hyaline-granular casts after exercise. There were modest increases in urinary white-cell counts in 35 subjects but little change in urine pH or osmolality with exercise.

This study confirms that urinary red-cell counts commonly increase appreciably after exercise. The dysmorphic appearance of the red cells together with the presence of red-cell casts indicates a glomerular source for this common form of exercise haematuria.

Introduction

Exercise-induced urinary abnormalities were first described in 1907, when Collier found proteinuria after rowing and running.[1] Subsequent studies have found haematuria with or without proteinuria and cylinduria after a wide variety of exercises.[2-8] Haematuria after exercise was considered by early workers to be of glomerular origin because of the presence of casts including red-cell casts.[2-5] More recent studies have suggested that exercise haematuria arises from the lower urinary tract, and bladder lesions have been detected at cystoscopy.[6-8] Previous workers have used semi-quantitative methods counting cells per high-power field, which are inaccurate[9]; they have not used phase-contrast microscopy, which permits better definition of red-cell morphology and easier recognition of red-cell casts.[10-12] This might account for discrepancies between findings of previous studies.

The morphology of urinary red cells on phase-contrast microscopy has recently been used to distinguish between glomerular haematuria and bleeding from other urinary tract lesions.[10-14] Normal urine may contain up to 8000 red cells that are glomerular in type/ml (DFB and KFF, unpublished observation). We examined midstream urine samples before and after exercise to determine the site of origin of exercise-induced haematuria.

Subjects and methods

We collected midstream urine samples from 48 subjects (47 male, one female; mean age 31·4 years (range 8-45 years)) before and after a long-distance run. Forty-one subjects ran 9 km and seven ran 14 km.

Urine samples were tested with Bili-Labstix for pH, protein, and blood. Ten millilitres of urine was then centrifuged for 10 minutes at 750 *g*, 9·5 ml of supernatant removed, and the resuspended sediment examined in a Fuchs-Rosenthal counting chamber using an Olympus BH microscope with a positive phase-contrast attachment. Numbers of red blood cells, white blood cells, and casts were counted and red-cell morphology assessed as either glomerular or non-glomerular as previously described.[10-14] Urine osmolality was determined by freezing-point depression.

Results

Testing with Bili-Labstix showed a trace of protein in samples from six subjects before exercise; after exercise 21 samples showed a trace of protein, 11 showed +, and seven showed ++; one of these seven also developed pyuria. Blood was not detected by Bili-Labstix before exercise; after exercise only three subjects showed a trace of blood and two showed +.

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Urinary red-cell counts before exercise were less than 10 000 cells/ml in all 48 subjects; 44 had counts less than 8000 cells/ml. (In another study we found that red-cell counts in 95% of 376 healthy subjects were $\leqslant$8000 cells/ml and 99% of the subjects had counts of $\leqslant$10 000 cells/ml.) There was an appreciable rise in urinary red-cell counts after exercise in all but four subjects (fig 1). After exercise 33 subjects had counts above normal (8000/ml), and in 19 of these subjects counts were more than double the highest value observed before exercise (that is, >20 000 cells/ml). Seven subjects had counts of >50 000 cells/ml, and two of 200 000 cells/ml. There was a clear association between after-exercise proteinuria and haematuria: 14 of the 18 subjects with + or ++ proteinuria had red-cell counts after exercise of >20 000 cells/ml compared with only six of the 30 subjects with a trace of or no protein.

In all subjects urinary red blood cells were dysmorphic both before and after exercise (fig 2). The two subjects who had red-cell counts after exercise of 200 000/ml also had ++ proteinuria and red-cell casts.

Casts were detected in few samples before exercise. Eight subjects, however, had >100 casts/ml (range 250-5000/ml) before running and in each case these were hyaline or hyaline-granular casts. Only two of these subjects had haematuria after running, and they also had ++ proteinuria. All 48 runners had high counts after effort (range 500-200 000, median 14 000 casts/ml). Red-cell casts (fig 3) were detected after exercise in 10 subjects.

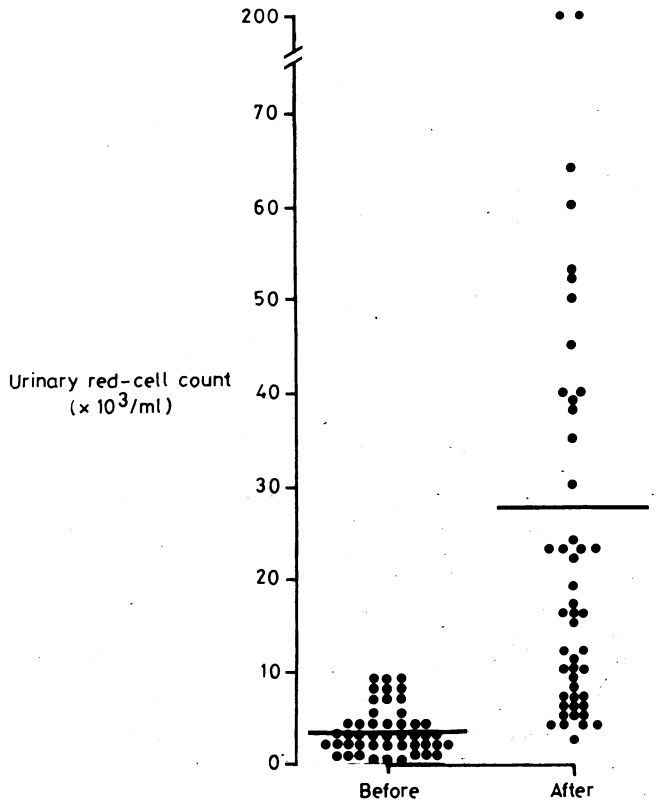

FIG 1—Urinary red-cell counts before and after exercise. (Significance of rise after exercise $p < 0{\cdot}0005$.)

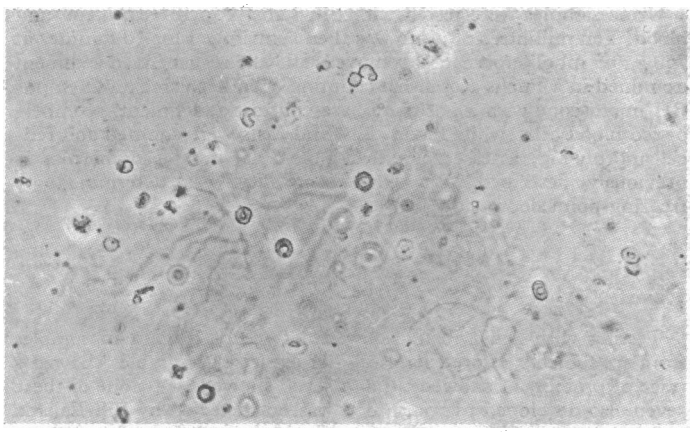

FIG 2—Glomerular haematuria, showing dysmorphic red blood cells varying in size and shape. Phase contrast ×1200 (original magnification).

FIG 3—Red-cell cast in urine after exercise. Phase contrast ×450 (original magnification).

Urinary nucleated cells (leucocytes and tubular epithelial cells) were counted in 45 subjects, of whom 33 had increased counts after exercise. Before running 38 subjects had <2000 cells/ml and seven had 2000-10 000 cells/ml. In contrast, only 19 subjects had <2000 cells/ml after exercise and 22 had 2000-10 000 cells/ml. Four subjects had after-exercise counts of >10 000 cells/ml, of whom one had $>10^6$ cells/ml.

There was little change in urine pH after exercise, the mean value before exercise being $6{\cdot}2 \pm 0{\cdot}4$ and after exercise $5{\cdot}9 \pm 0{\cdot}5$. There was also no significant change in urine osmolality, the mean before exercise being 703 ± 258 mmol(mosmol)/kg and after exercise 685 ± 223 mmol/kg.

Discussion

The phenomenon of proteinuria, haematuria, and cylinduria after exercise has been documented, but there has been disagreement regarding the origin of the urinary red blood cells. The finding of casts, including red-cell casts, in two studies implied a glomerular origin of the haematuria.[2 5] More recent studies failed to find any casts,[6] and because bladder lesions have been detected on cystoscopy these have been regarded as the source of exercise haematuria.[6 7] This discrepancy over casts may reflect the semi-quantitative methods used and failure to use phase-contrast microscopy.

In this study 42 out of 48 runners showed an increase in urinary red blood cells with exercise and in 33 the count rose to levels above normal. Nineteen subjects had red-cell counts above 20 000/ml after exercise. This is well within the range seen in glomerulonephritis under resting conditions.[11] The presence of red-cell casts in 10 runners and the dysmorphic appearance of the urinary red blood cells indicates that the haematuria was of glomerular origin. These changes occurred with little or no change in urine osmolality or pH. Interestingly, only five samples yielded a positive result on dipstick testing for blood, and possibly fruit juice, which was freely available to the runners, provided sufficient ascorbic acid to interfere with the test.

Because casts were found in all but two specimens after exercise we cannot support the view of Siegel *et al*[8] that the appearance of casts after exercise should be attributed to intrinsic renal causes until proved otherwise. Whereas most subjects in the present study had hyaline or hyaline-granular casts after exercise, urine samples from 10 runners contained red-cell casts and all but one of these also had + or + + urinary protein on dipstick testing. Two subjects showed trace amounts of urine protein before exercise and developed heavy proteinuria, high red-cell counts, and red-cell casts after exercise and may well have had underlying renal disease.

Nine runners had high cast counts before exercise, but the importance of these is uncertain. Only two of the nine developed haematuria after running, and both of these also developed proteinuria.

The present study also showed an increase in urinary nucleated-cell counts after exercise in 35 runners, and in one subject this rose to $>10^6$ cells/ml. Often, however, it is not feasible to identify precisely the types of cells recorded as urinary "leucocytes," and in some cases renal tubular cells may possibly have been counted. Further study of this is warranted since if these are renal tubular cells they may be a precursor of acute tubular necrosis, which has been reported after strenuous exercise.

The results of this study confirm that increased glomerular bleeding occurs in most subjects after long-distance running. In some the haematuria may be considerable and accompanied by proteinuria and the presence of red-cell casts. We did not observe non-glomerular haematuria, and if non-glomerular haematuria develops after this degree of exercise cystoscopy may be warranted.

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Alcohol abstention and premature mortality in middle-aged men

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Abstract

A series of middle-aged men were investigated for total mortality up to five years after completing a questionnaire on alcohol consumption administered during a preventive medical screening programme in Malmö, Sweden. The aim was to test the hypothesis that small amounts of alcohol are beneficial to general and cardiovascular health.

Relative mortality was increased among the men who had reported non-use of alcohol in the screening questionnaire. Most of these men, however, had chronic disease as the reason for their abstention, or even a past history of alcoholism.

Increased mortality in non-drinkers may create a false impression of a preventive effect of any versus no daily drinking in relation to general and cardiovascular health.

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Introduction

Several studies have suggested that small amounts of alcohol may be beneficial for general and cardiovascular health.[1-6] A "cardioprotective" effect of alcohol has been postulated, mediated by, for example, decreased platelet aggregation and coagulation or increased α-lipoprotein concentrations, or both.[1-6] These studies have partly been based on comparing mortality ratios in drinkers and non-drinkers, which tend to support "a small preventive effect of any versus no drinking."[2] As a group, however, "abstainers" may not represent people with a smooth continuum of non-drinking but be widely heterogeneous both in their past history of alcohol use and in their morbidity composition. For example, a substantial proportion of non-drinkers may have diagnosed or symptomatic illness as the main reason for their current abstinence, and some may be temporarily reformed alcoholics.

In a preventive medical screening programme in Malmö we administered a questionnaire on alcohol consumption[7] and used biochemical markers of alcohol-related metabolic effects.[8] We