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Oxygen Affinity of Hemoglobin in Postmenopausal Women

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Abstract:

In a group of 12 postmenopausal women the P_{50}-value (i.e. half saturation tension of oxygen) and other parameters of the red blood count were determined and compared with values of a male group of the same age. A small but significant difference could be found between the hematocrit values but no other values differed. In particular, the sex difference in oxygen affinity reported earlier does not exist in men and women on this age group.

Key-words: oxygen affinity of hemoglobin - 2,3-diphosphoglycerate - postmenopausal women.

As reported previously sex differences exist in the oxygen affinity of hemoglobin, women showing a lower oxygen affinity of hemoglobin than men (2). We were recently able to show that this sex difference is not present before puberty, but that during puberty the mean P_{50}-value (= half saturation tension at pH 7.4) in the female group increases and becomes significantly higher than in the male group (3). The present investigation was undertaken to provide information as to whether the oxygen affinity of hemoglobin in postmenopausal womes is also different from that of men.

Methods:
Venous blood samples from 12 female and 12 male non-smoking, healthy subjects were examined. The mean age of the females was 56.6 years, varying between 48 and 74 years with an average of 11 years since the last menstrual period. The men were 43 to 77 years old (mean: 58.2 years). For analysis of the oxygen dissociation curve the microequilibration technique of Astrup (1) was used, the blood being exposed to humidified gas mixtures of known composition in thermostated (37°C) microtonometers. The oxygen and carbon dioxide contents of the gas mixture, which was prepared from pure nitrogen, carbon dioxide and oxygen with Wösthoff-gas-mixing pumps, were continuously measured using a Beckman oxygen analyzer and a Hartman and Braun URAS apparatus. After equilibration the oxygen saturation of hemoglobin was measured with the Radiometer OSM II and the pH with a micro glass electrode of the Radiometer BMS II. The P_{02} of the equilibrating gas mixture was corrected to pH 7.4 according to Severinghaus (6) using a Bohr coefficient of -0.48. The values of log $S_{02}/(100 - S_{02})$ were plotted against those of log P_{02} and the P_{50} then determined graphically. Hemoglobin, hematocrit and red cell counts were conducted according to standard hematological techniques. Mean corpuscular hemoglobin concentration (MCHC) was calculated by dividing hemoglobin concentration by hematocrit, the mean corpuscular hemoglobin (MCH) by dividing hemoglobin concentration by red cell count. The intraerythrocytic 2,3-diphosphoglycerate concentration was measured using the method of Rose and Liebowitz (4) and calculated as µmol/g hemoglobin. For statistical analysis Wilcoxon's U-test was used (5).

Results
The results are listed in table 1. A small but significant difference exists only between the hematocrit values. No differences could be found between the other values of the red blood count. Male and female groups also show identical P_{50}-values of 3.43 kPa (± 0.03 kPa S.E.M.) and nearly the same level of intraerythrocytic 2,3-diphosphoglycerate.

Discussion
In earlier studies we were able to show that hemoglobin of females has a lower oxygen affinity than that of males (2). This sex difference does not exist before puberty (3). During puberty the mean P_{50}-value in the female group increases although the hemoglobin concentration does not change, while in the male group no variations of the oxygen affinity could be found during puberty dispite increased hemoglobin concentration (3).

Table 1: Mean values and standard errors of the mean (± S.E.M.) of hemoglobin concentration (Hb), hematocrit (Hct), red cell count (r.c.), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), arterial blood pH, half-saturation tension (P_{50}) at pH 7.4 and 2,3-diphosphoglycerate concentration (2,3-DPG)

	♀ n=12	♂ n=12	
Age y	56.6	58.2	
Hb g/l	146.4 ± 3.5	151.2 ± 3.1	n.s.
Hct	0.43 ± 0.005	0.45 ± 0.006	$p < 0.01$
r.c. 10^{12}/l	4.3 ± 0.1	4.7 ± 0.1	$0.05<p<0.1$
MCHC g/l	341 ± 5.8	335 ± 4.4	n.s.
MCH pg	34 ± 0.9	33 ± 1.0	n.s.
pHa	7.40 ± 0.01	7.41 ± 0.01	$0.05<p<0.1$
P_{50} kPa (mmHg)	3.43 (25.7) ± 0.03 (±0.2)	3.43 (25.7) ±0.03 (± 0.2)	n.s.
2,3-DPG µmol/g Hb	13.1 ± 0.1	13.6 ± 0.3	n.s.

This study reveals no sex difference, either in hemoglobin concentration or oxygen affinity, between a postmenopausal female group and a male group of the same age. The reason for this and for earlier findings is not known, although it is tempting to speculate that the oxygen affinity of hemoglobin is also regulated by sexual hormones in such a way that the release of oxygen from hemoglobin is facilitated in sexually mature women.

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