PERIPHERAL BLOOD AND BONE MARROW INDICES IN HEALTHY DOGS

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Changes in the morphologic composition of peripheral blood and of bone marrow are very important in evaluation of the state of the organism and in various diseases as well as in various experimental investigations.

This necessitates definite knowledge of the morphologic composition of peripheral blood and hemopoietic organs in healthy animals, in particular in dogs. However, data available in the literature are inadequate. The majority of authors base their conclusions on relatively scant and heterogeneous material, so that statistical treatment shows [7] some of the differences found to be nonsignificant.

The average value given by most investigators for the number of erythrocytes is 6-7 million per 1 mm^3 of blood. The limits of fluctuation, however, allowed by some authors are very wide. A. F. Aleksandrov [1], for instance, considers the range of normal erythrocyte content in dogs to be from 3.96 to 8.4 million, while V. Bauman [2] extends it to 2.5-10 million. The same can be said concerning the color index the upper limit of which is taken to be 1.24-1.4 [5].

Reticulocytes have only been estimated by two investigators – E.C. Albritton [9] and G. A. Ryazhkin [7] whose data are widely divergent: 0-27 and 0-2.9 respectively

The total number of thrombocytes has been determined by many authors. Average values reported have been within the range of 300,000-500,000 cells per 1 mm^3 blood with a wide scatter of fluctuations from 188,000 to 960,000 [9]. Ryazhkin [7] reports lower values for the number of thrombocytes (average – 150,000) with fluctuations from 48,000 to 250,000.

The average number of leucocytes given by many authors varies within the limits of 9,000-10,000 per 1 mm^3 of blood with fluctuations from 6,000 to 12,000 or 15,000. At the same time, A. F. Aleksandrov, E. C. Albritton and G. A. Ryazhkin take higher values as normal (12,000-13,000) with fluctuations from 7,800 to 16,800, 18,000 or 20,000.

As regards the percentage composition of the leucocyte formula, the data of most authors are consistent (60-70% cells of the neutrophil series and 20-25% lymphocytes). G. A. Ryazhkin's data form an exception: he takes 12% lymphocytes (from 3 to 18%) as normal.

The average percentage of eosinophils equals 3-6 with fluctuations from 0-3 to 6-17 while that of basophils equals 0.5-1 with fluctuations from 0 to 1.2.

The average quantity of monocytes is within the limits of 3-7% with fluctuations from 1-4 to 4-10%. Aleksandrov's data are an exception since he takes marked monocytosis (22.5%) as the upper limit of normal Plasma cells have been determined by only three investigators – Aleksandrov, A. I. Ermolenko [3] and G. A. Ryazhkin who found them to amount to 0.4-2.25%.

The erythrocyte sedimentation rate according to A. V. Kudryavtsev [5] is within the range of 2-3.5 mm/hour and according to G. A. Ryazhkin – 6-15 mm/hour.

Information concerning the percentage content of cells in bone marrow is available in the work of several authors [1, 2, 8 and 9]. The data, however, are divergent, not related to peripheral blood findings and differ as regards cell nomenclature.

According to Stesni and Higgins, van Loon, Mulligan, Reckers, Caulter [9] and I. I. Tarasov [8] the number of erythroblast cells in the normal constitutes 40-59% and of myeloid cells – 34.5-53.4%.

According to Aleksandrov's statistics erythroblast cells make up 14-32% and myeloid cells 34.3-56.2%. Ryazhkin's figures are 30% for erythroblast and 52% for myeloid cells.

It follows from the above that fluctuations in the myeloid cell content are smaller than those in the erythroblast cell content.

Subdivision of cells according to degrees of maturation has not been done by all authors.

E.C. Albritton, analyzing the figures reported by four investigators, calculates the content of immature forms of the red and white series in percentage of the total number of bone marrow cells (100). This shows that immature erythroblasts make up 5.4% (1.8-8.4%) while immature regenerative cells of the myeloid series make up 7.4% (4-14.1%).

In view of the divergence and paucity of literature data it was decided to present the results of our investigations carried out on 200 dogs.

EXPERIMENTAL RESULTS

As can be seen from Table 1, the number of erythrocytes in the dogs examined in 6.6 million, the color index is, on the average, 0.57 and the amount of reticulocytes constitutes 8% . The absolute number of thrombocytes equals, on the average, 304,000.

1 mm^3 of blood contains 10,500 leucocytes with fluctuations from 6,000 to 14,000.

Analysis of the leucocyte formula reveals the neutrophil leucocytes make up, on the average, 64.5% (40-86%), lymphocytes – 19.5% (12-34%), monocytes – 6% (0-13%), eosinophils – 7% (0-20%) and plasma cells 0.67% (0-2%). Single basophils were only seen in a few dogs. The average ESR value was 3.6 mm/hour with fluctuations from 1 to 12 mm/hour.

TABLE 1

Normal Values for Peripheral Blood in Dogs

Index	Average values	Maximal values	Minimal values	Average quadratic deviation	Average arithmetic mean error
Erythrocytes (in millions)	6 6	8.4	5.2	±0.74	±0.05
Hemoglobin (in units)	75	94	60	±8.56	±0.6
Color index	0.57	0.76	0.50	±0.06	±0.04
Reticulocytes (in %)	8	18	1	±3.8	±0.26
Thrombocytes (in %)	48	80	25	±10.83	±0.69
Thrombocytes (in thousands)	304	500	60	±71.2	±5.03
Leucocytes (in thousands)	10.5	14.0	6.0	±1.86	±0.13
Rod-nucleated neutrophils (in %)	4	10	0	±2.28	±0.14
Segment-nucleated neutrophils (in %)	60.5	76	40	±7.52	±0.53
Neutrophils (absolute number)	6.9	10.0	3.6	±1.41	±0.09
Lymphocytes (in %)	19.5	34	12	±5.28	±0.38
Lymphocytes (absolute number)	2	3.8	0.8	±0.697	±0.04
Eosinophils (in %)	7	20	0	±4.65	±0.25
Eosinophils (absolute number)	0.7	3.0	0.2	±0.54	±0.03
Monocytes (in %)	6	13	0	±3.31	±0.23
Monocytes (absolute number)	0.6	1.6	0.2	±0.30	±0.02
Plasma cells (in %)	0.67	2	0	±0.66	±0.046
ESR (mm/hour)	3.6	12	1	±2.27	±0.227

The figures obtained by us thus approach in most cases those cited in the literature, but in some cases (total number of reticulocytes and percentage content of eosinophils) our values are higher.

Passing on to an analysis of the percentage composition of bone marrow cells (Table 2), the average values for erythroblast cells, according to our data, are 27.9%, for myeloblast cells – 57.43% and for all other cells 15.67%. Subdivision of the red and white series cells according to degree of maturation, expressing the values as percentage of total bone marrow cells (100) shows that immature regenerative cells of the erythroblast series constitute 2.3% (0.2-8.8%) while immature regenerative cells of the myeloid series constitute 5.4%. (1.2-13.4%).

TABLE 2

Normal Bone Marrow in Dogs

Index	Average values	Maximal value	Minimal value	Average quadratic deviation	Average arithmetic mean error
Hemohistoblasts	0.16	1.2	0	±0.3	±0.02
Reticulo-endothelial cells	1.0	4.0	0	±0.468	±0.03
Pre-erythroblasts	0.9	3.2	0	±0.566	±0.04
Basophil macroblasts	1.4	5.6	0.2	±1.4	±0.1
Basophil normoblasts	7.8	27	1	±4.99	±0.35
Polychromatophil normoblasts	17	34	6	±6.24	±0.44
Oxyphil normoblasts	0.8	4.8	0	±0.09	±0.07
Total number of erythroblast cells	27.9	44	16		
Mitoses in red series	1.0	2.4	0	±0.59	±0.04
Myeloblasts	0.9	3.0	0	±0.64	±0.04
Premyelocytes	1.9	4.4	0.2	±1.04	±0.07
Myelocytes	2.6	6	1	±0.95	±0.06
Young	6	18	2	±3.18	±0.22
Rod-nucleated neutrophils	27	48	6	±7.55	±0.53
Segment-nucleated neutrophils	15	42	6	±7.81	±0.55
Eosinophils	4.0	10.0	1	±1.87	±0.13
Basophils*		0.8	0		
Total number of myeloid cells	57.43	74	40		
Lymphocytes	4	12	0	±2.66	±0.19
Monocytes	2.5	11	0	±2.19	±0.15
Megakaryocytes*		1.2	0		
Megakaryoblasts*		0.8	0		
Mitoses in white series*		1.6	0		
Ferrata cells*		1.2	0		

*Average values were not calculated because of large numbers of zero values.

Analysis of fractional composition showed that young erythroblasts (pre-erythroblasts and basophil macroblasts) constituted 8% of the total number of erythroblast cells and young elements of the myeloid series (myeloblasts, premyelocytes and myelocytes) constituted 9% of the total cells in the white series.

Thus, our findings indicate that in the bone marrow of healthy dogs (mongrels) myeloid elements predominate over erythroblast elements, and mature forms over immature forms.

At the same time qualitative changes, described in detail by A. P. Egorov [4], were also encountered in animals. We found in smears of peripheral blood: hypersegmentosis 0.2% (0-3.5%), fragmentation 1.4% (0-8%), giant forms 0.14% (0-3%), chromatolysis 0.73% (0-4%) and granulocyte cytolysis 1.24% (0-6%), and agranulocytes 1.43% (0-8%). Bone marrow smears showed: pyknosis 2.52% (0-10.6%), chromatolysis 1.07% (0-7.8%), rhexis 0.13% (0-1%), giant forms 0.17% (0-5.5%), hypersegmented forms 0.13% (0-1.2%), fragmentation 0.36% (0-3.2%), vacuolization of cells 0.17% (0-1.6%), cytophagia 0.03% (0-0.7%), pigment 0.12% (0-1.2%), cytolysis 13.4% (2-35%).

SUMMARY

Determinations of various indices of peripheral blood and bone marrow of 200 healthy dogs were analyzed statistically and are presented in this paper. The average values for erythrocytes (6.6 million), leukocytes (10,500), thrombocytes (304,000), reticulocytes (8%) and erythrocyte sedimentation rate (3.6 mm per hour) are very close to those mentioned in literature. Numerical values, reflecting the contents of erythroblastic (27.9%) and myeloid (57.43) elements of the bone marrow differ to a certain extent from the corresponding data of I. I. Tarasov and A. F. Alexandrov. The numerical indicators of qualitative changes of the cells of peripheral blood and bone marrow are presented in this work.

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* In Russian.

** Original Russian pagination. See C. B. Translation.