Functional Asymmetry of the Brain and Bone Marrow in Hemopoiesis in (CBA×C57Bl/6)F_1 Mice

V. V. Abramov, I. A. Gontova, and V. A. Kozlov

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 133, No. 5, pp. 541-543, May, 2002
Original article submitted February 12, 2002

The role of functional asymmetry of the brain and bone marrow in the formation of exogenous 8-day splenic CFU was studied in (CBA×C57Bl/6)F_1 mice. The intensity of hemopoiesis depended on the motor asymmetry of donors and recipients of bone marrow cells and differed for bone marrow transplantations from the right and left femoral bones.

Key Words: *asymmetry; bone marrow; brain; hemopoiesis*

There are good grounds to believe that functional asymmetry of cerebral hemispheres and paired endocrine organs is an essential peculiarity of their functions extending adaptive potentialities of the respective systems [2,3,5, 9,10].

We have shown that paired organs of the immune system (thymus, bone marrow, and lymph nodes) are also functionally asymmetrical [1-4,6,7]. It was demonstrated that interrelated asymmetry of the cerebral hemispheres and thymic lobes determined the intensity of cell and humoral immune responses in experimental animals [2-4,6,7]. It remains unclear whether asymmetry of the brain and bone marrow is significant for hemopoiesis. The present study addresses this problem.

MATERIALS AND METHODS

Male (CBA×C57Bl/6)F_1 mice from Tomsk Breeding Center were used in experiments. The animals were kept in a vivarium in plastic cages (10 per cage) on balanced rations with free access to water.

Hemispheric asymmetry (motor asymmetry) was tested by paw preference in getting food [8]. The test was carried out 3 times with 3-day intervals. The mice retaining motor asymmetry parameters at all tests (right- and left-pawed) were used in further studies.

Institute of Clinical Immunology, Siberian Division of the Russian Academy of Medical Sciences, Novosibirsk. ***Address for correspondence:*** valery_abramov@mail.ru. Abramov V. V.

Exogenous colony formation was evaluated by the number of 8-day colonies in the spleen (CFUs-8) [11].

For investigation of the effect of motor asymmetry on exogenous colony formation, the donors and recipients were divided into groups of left- and right-hemispheric animals.

The effect of functional asymmetry of the bone marrow on hemopoiesis was evaluated by injections of cells from the left or right femoral bone of left- or right-hemispheric donors to irradiated recipient animals (left- or right-hemispheric).

The results were statistically processed using Student's *t* test for independent samplings.

RESULTS

Evaluation of functional asymmetry of the bone marrow showed significant differences in the formation of CFUs-8 only in lethally irradiated right-hemispheric recipients receiving bone marrow cells from the right or left femoral bones of the right-hemispheric donors (Fig. 1, RRR-RLR groups). No appreciable differences in the formation of CFUs-8 were observed in cases when left and right bone marrow cells were transplanted to right-hemispheric recipients from left-hemispheric donors or such cells from right- and left-hemispheric donors were injected to left-hemispheric recipients.

The results indicate that the hemopoietic potential of the bone marrow from the right and left femoral bones is different, which agrees with published reports [1-4]. On the other hand, manifestation of asymmetry

0007-4888/02/1335-0468$27.00

of bone marrow hemopoietic functions depends on motor asymmetry of donors and recipients.

The study of the role of motor asymmetry of bone marrow donors in the formation of CFUs-8 in the spleens of lethally irradiated recipients showed that cells from the right femoral bone of left-hemispheric donors were characterized by more intense hemopoiesis in the spleens of right- and left-hemispheric recipients compared to cells from right-hemispheric donors (Fig. 1, LRR—RRR and LRL—RRL groups). No significant differences between the groups were observed after transplantation of the bone marrow from the left femoral bone.

Hence, the bone marrow from the right femoral bone of left-hemispheric donors possesses higher hemopoietic potential compared to that of right-hemispheric animals. On the other hand, hemopoietic functions of the bone marrow from the left femoral bone do not depend on motor asymmetry of donors.

Analysis of the relationship between motor asymmetry in irradiated recipients and the number of CFUs showed that the differences between the groups were significant only when irradiated mice were injected with bone marrow cells from the left femoral bone of right-hemispheric donors (Fig. 1, RLR—RLL groups): the number of colonies in the spleens of right-hemispheric recipients was significantly higher than in left-hemispheric animals. On the other hand, the formation of CFUs-8 in left- and right-hemispheric recipients did not differ significantly in all other combinations.

Hence, the bone marrow taken from the left femoral bone is functionally more active in right-hemispheric recipients than in left-hemispheric ones. Hemopoietic functions of the bone marrow from the right femoral bone do not depend on the recipient's motor asymmetry.

Our findings suggest that the formation of CFUs-8 in recipients depended on the motor asymmetry of donors and recipients and on the source (right or left femoral bone) of the bone marrow. Bone marrow cells from the left femoral bone can induce the formation of higher number colonies compared to those from the right femur; bone marrow cells from left-hemispheric donors ensure more intensive hemopoiesis compared to those from right-hemispheric donors; in right-hemispheric recipients the number of splenic colonies was higher than in left-hemispheric ones.

It is noteworthy that the differences between the groups were also significant in cases when two of the three studied parameters changed simultaneously.

For example, hemopoiesis depends on both bone marrow asymmetry and motor asymmetry of cell donors. Injection of bone marrow cells from the right femoral bone of left-hemispheric donors to left-hemispheric recipients led to the formation of significantly more colonies than after injection of cells from the left femoral bone of right-hemispheric donors to the same recipients (Fig. 1, LRL—RLL groups). The numbers of CFUs-8 differed significantly in right-hemispheric recipients transplanted cells from the right femoral bone of right-hemispheric donors or cells from the left femoral bone of left-hemispheric donors (Fig. 1, RRR—LLR groups).

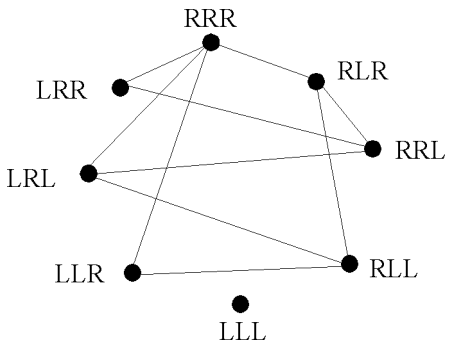

Fig. 1. Role of bone marrow and motor asymmetry of donors and recipients on the formation of 8-day splenic CFU in (CBA×C57Bl/6)F_1 mice. Results of paired multiple comparisons are shown; the lines connect groups differing significantly ($p<0.05$). The groups are denoted as follows: the first letter denotes the leading hemisphere in the donor, the second shows the side from which the bone marrow was taken, and the third letter denotes the leading hemisphere in the recipient.

Differences between the groups were significant when bone marrow asymmetry and motor asymmetry of recipients were changed simultaneously. If left bone marrow cells from right-hemispheric donors were injected to right-hemispheric recipients (RLR), the number of splenic colonies was more than after transplantation of right bone marrow cells from right-hemispheric donors to left-hemispheric donors (RRL). In other words, the combination of donor bone marrow asymmetry and recipient motor asymmetry is significant for hemopoiesis intensity.

Combined modulation of bone marrow donor and recipient motor asymmetry also resulted in significant changes between the groups. Such differences were observed when, for example, recipients were transplanted bone marrow cells from the right femoral bone, but motor asymmetry in the groups was changed in both donors and recipients: right-hemispheric recipients were transplanted cells from right-hemispheric donors and left-hemispheric recipients received cells from left-hemispheric donors (RRR—LRL groups). Differences between the groups were also significant when the number of colonies was compared in left-hemispheric recipients transplanted right bone marrow cells from right-hemispheric donors (RRL) and right-hemispheric recipients transplanted right bone marrow cells from left-hemispheric donors (LRR).

With bone marrow cells from the left femoral bone, the differences between the groups were significant only

when the donor—recipient pair in each group was inverted for motor asymmetry (Fig. 1, LLR—RLL groups).

These data indicate combined effects of motor asymmetry of bone marrow donors and recipients on the number of splenic colonies.

Hence, our experiments once more confirmed the existence of functional asymmetry of the bone marrow [1-4] and for the first time in the world demonstrated that the capacity of (CBA×C57Bl/6)F_1 donor bone marrow cells to hemopoiesis depends on motor asymmetry of these cells' donors and recipients and on the functional asymmetry of the bone marrow.

REFERENCES

1. V. V. Abramov, *Interactions between the Nervous and Immune Systems* [in Russian], Orenburg (1990), P. 172.
2. V. V. Abramov, *Complex Mechanisms of Interactions between the Immune and Nervous Systems*, Abstract of Doct. Med. Sci. Dissertation, Moscow (1991).
3. V. V. Abramov, V. I. Konenkov, I. A. Gontova, *et al.*, *Dokl. Rossiisk. Akad. Nauk*, **322**, No. 4, 802-805 (1992).
4. V. V. Abramov and T. Ya. Abramova, *Nervous, Endocrine, and Immune Systems Asymmetry* [in Russian], Novosibirsk (1996).
5. V. L. Bianki, *Mechanism of Paired Brain* [in Russian], Leningrad (1989).
6. I. A. Gontova, V. V. Abramov, and V. A. Kozlov, *Byull. Eksp. Biol. Med.*, **131**, No. 1, 78-80 (2001).
7. I. A. Gontova, V. V. Abramov, and V. A. Kozlov, *Immunologiya*, No. 2, 30-32 (2000).
8. J. Bures, O. Buresova, and J. P. Huston, *Techniques and Basic Experiments for the Study of the Brain and Behavior*, 2nd ed., Amsterdam (1983).
9. I. Gerendai and B. Halasz, *Front. Neuroendocrinol.*, **18**, No. 3, 354-381 (1997).
10. P. J. Neveu, *Behav. Genet.*, **26**, No. 4, 373-377 (1996).
11. J. E. Till and E. A. McCulloch, *Rad. Res.*, **14**, No. 2, 213-222 (1961).