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# The Microcirculatory Bed of Hamster Cheek Pouches after Occlusion of the Common Carotid Arteries

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny,* Vol. 121, № 2, pp. 144-147, February, 1996
Original article submitted March 6, 1995

The responses of hamster cheek pouch microvessels after occlusion of the common carotid artery on the ipsilateral side are compared. It is found that under conditions of limited inflow the microvessels preserve the inflow on the left side and the outflow on the right side, with venular constriction predominating in the left cheek and arteriolar in the right.

**Key Words:** *microvessels; morphometry; ischemia; asymmetry*

The state of the microcirculation in organs remote from the brain under conditions of limited blood flow to the latter has been discussed repeatedly [2]. The differences in the microcirculatory bed (MB) of paired structures have been studied. Morphofunctional asymmetry has been established for pial vessels in symmetrical areas of the feline brain [9], microvessels of rabbit ears, hamster cheek pouches, and symmetrical fragments of frog lingual vessels [3-6]. Hemodynamic characteristics of the symmetrical common carotid arteries have been studied and their functional lability has been demonstrated [7,8]. In view of the fact that blood is supplied to hamster cheeks from the common carotid arteries, it can be hypothesized that restriction of the blood flow to the brain will be reflected in the microcirculation of the cheeks. In the present study we analyzed microcirculatory disorders in hamster cheeks after occlusion of the common carotid artery on the ipsilateral side.

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## MATERIALS AND METHODS

Experiments were performed on 10 hamsters (140-180 g) under Nembutal anesthesia (0.09 mg/g body weight). Biomicroscopy of the vascular bed was performed by the method of transparent chambers [10]. The field of view was illuminated via an optical fiber

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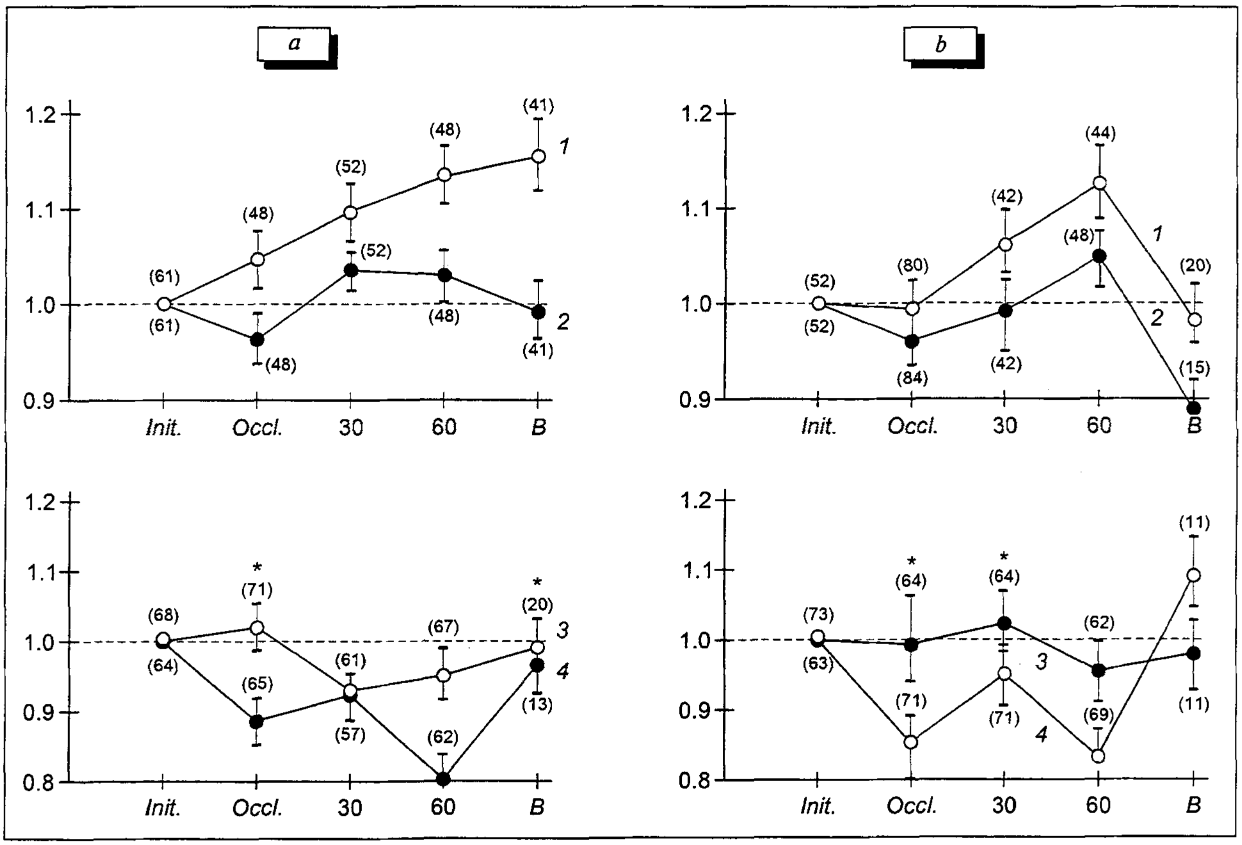

**Fig. 1.** Dynamics of morphometric parameters of microvessels of left (*a*) and right (*b*) hamster cheek pouches after occlusion of the carotid artery on the ipsilateral side. Ordinate: deviation of parameters from baseline level. Area occupied by LMB and RMB microvessels (*1*), their length (*2*), diameter of arterioles (*3*), and diameter of venules (*4*). The number of fragments of microvessels for each point is given in parentheses. An asterisk means the deviation is statistically insignificant. Here and in Fig. 2: *Init.* - after application of the transparent chamber, *Occl.* - immediately after the start of occlusion; *30* - at the 30th min of occlusion; *60* - at the 60th min of occlusion; *B* - after the termination of occlusion.

(magnification 63). In order to limit blood flow to the microvessels of the cheeks serfin was applied to the common carotid artery on the side where MB parameters were being measured. The microvessels were photographed immediately after the application of the transparent chamber, immediately after the application of serfin to the carotid artery, at the 30th and 60th min of occlusion, and after removal of the occluder. Microvessel projections were constructed from photographs of MB fragments, and the following morphometric parameters were measured [1]: the area, length, and diameter of perfused microvessels. The significance of differences was evaluated using Student's *t* test for conjugate pairs. The significance of differences in the occurrence of constrictions or dilatations in the entire aggregate of microvessels at different periods of observation relative to the first response to occlusion was evaluated by the $\chi^2$ test.

## RESULTS

Under conditions of occlusion of the carotid artery on the ipsilateral side, changes in the length of microvessels on the left and right sides were minor (Fig. 1). From the first few minutes of occlusion, the area occupied by microvessels on the left side (LMB) was greater than that occupied by the microvessels before occlusion. In the right-side microvascular bed (RMB), however, changes in area were noticeable only toward the 30th min after occlusion. The LMB area increased immediately after removal of the occluder, and the RMB became almost the same as before occlusion; postocclusion hypermemia was observed later. As shown in Fig. 1, on average, venular constriction was the response to occlusion of the left carotid artery and arteriolar constriction the response to occlusion of the right carotid artery. From the dynamics of the length and diameter of the microvessels on the right and left sides it can be concluded that the LMB "strives" to preserve the size of its arterioles (constriction was observed only at the 30th min of occlusion), while the RMB tries to preserve the size of its venules. It should be noted that as irreversible stasis developed in symmetrical fragments of the frog lingual MB, the arteriole was the last "to switch off" on the left side and the venule the last on the right side.

For analysis of heterogeneity of the vasomotor reactions in the LMB and RMB under conditions of limited blood flow, the dynamics of the frequency of deviations of the parameters from the baseline value at different periods of occlusion (immediately after ligation of the carotid arteries and after 30 and 60 min of occlusion) is shown in Fig. 2. An increase in area was a frequent response of the LMB to limited blood flow, while the RMB responded by a decrease in area. The length of the LMB microvessels increased or decreased with equal probability, whereas a decrease in length predominated in the RMB. The heterogeneity in the nature of the responses was probably associated with the different initial vascularization of MB fragments. In fact, LMB fragments with an initial vascularization of 112.6±9.26 arb. units responded to the reduced blood flow by a decrease in area, while fragments with an initial vascularization of 86.9±4.2 arb. units responded by an increase (the difference in vascularization was 41%). This also held true for the length of LMB vessels. In the RMB, the mean areas of fragments with opposite reactions did not differ much in terms of initial vascularization. The equiprobable deviation of bed length at the beginning of occlusion did not depend on this parameter. It should be noted that according to the $c^2$ test, the differences between the LMB and RMB in the occurrence of fragments with opposite responses in terms of area and length were significant only during the intital period of the response to limited blood flow.

We see from Fig. 2, that LMB arterioles respond to carotid artery occlusion by constriction or dilatation with equal probability, while for the RMB this is true of venules. Constriction predominated in RMB arterioles and LMB venules. According to the $\chi^2$ test, the differences between the LMB and RMB are significant for all periods of occlusion only in the case of arterioles. The difference between the two beds in the distribution of venules is not so pronounced.

Figure 3 shows that the heterogeneity of the responses of the RMB and LMB illustrated in Fig. 2 can

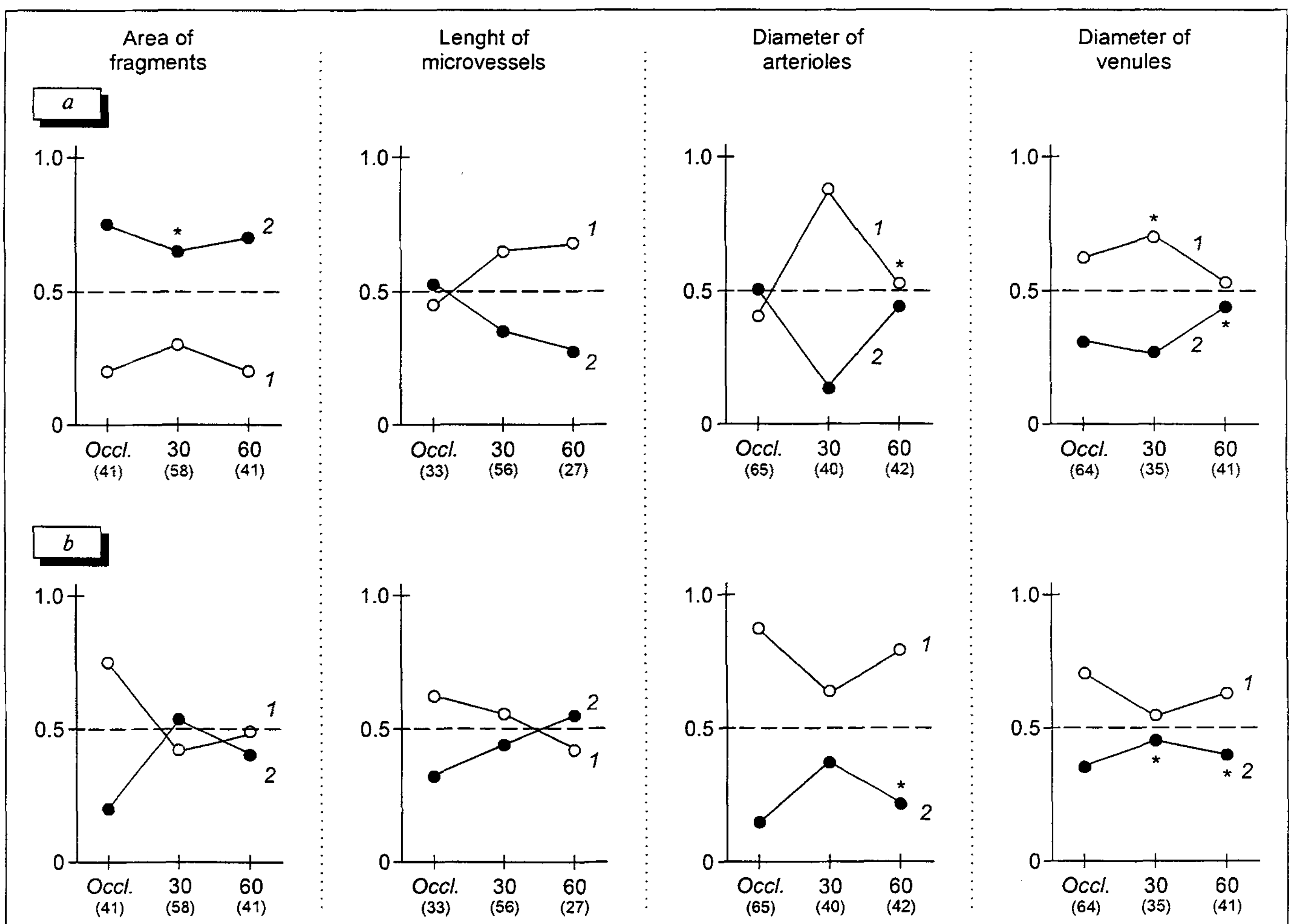


**Fig. 2.** Occurrence of opposite deviations of parameters of microvessels in LMB (*a*) and RMB (*b*) during occlusion of the carotid artery on the ipsilateral side. Ordinate: occurrence of microvascular bed fragments or microvessels with constriction (*1*) and dilatation (*2*). The total number of fragments or microvessels for each observation period is given in parentheses. An asterisk means the deviation is statistically insignificant compared with that at the beginning of occlusion.

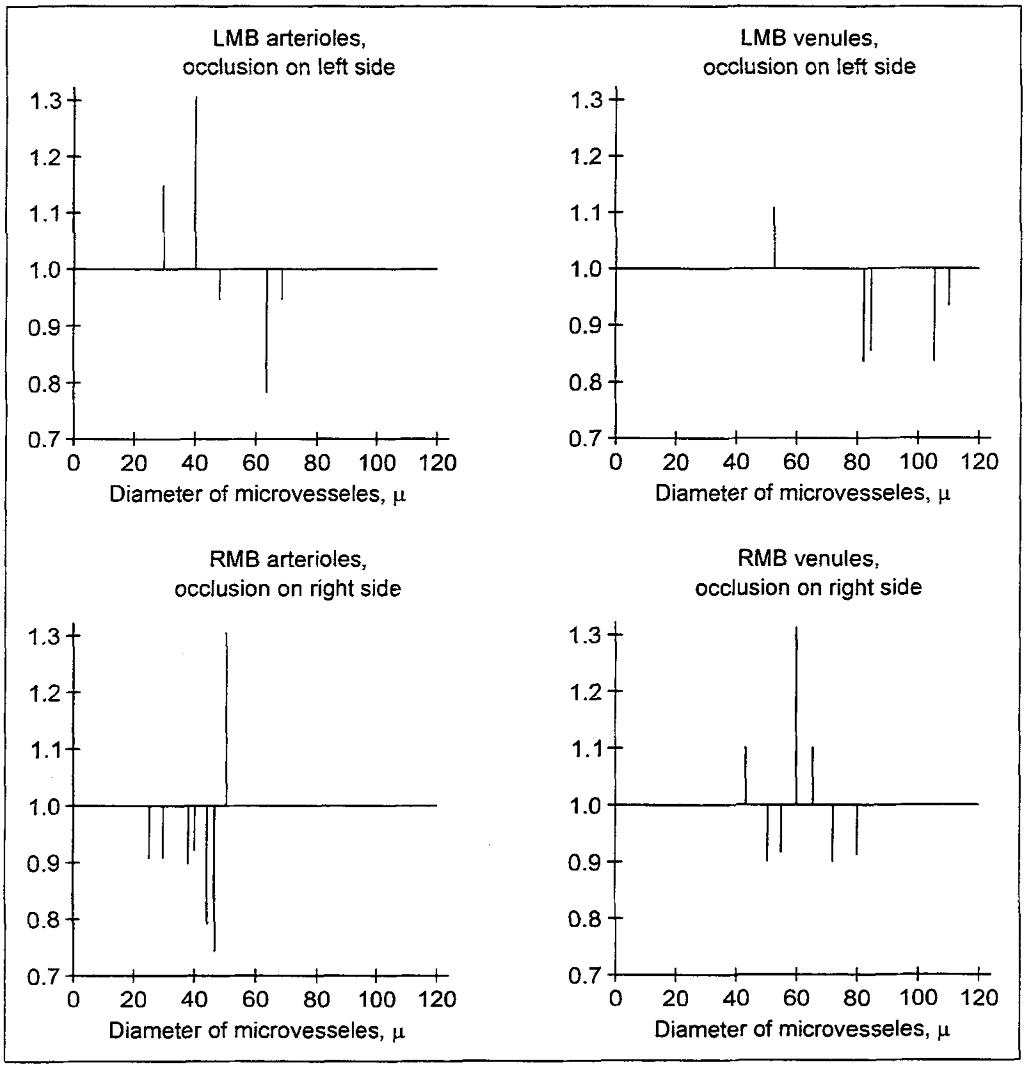


**Fig. 3.** Relationship between vasomotor reaction of LMB and RMB microvessels and their size at the start of occlusion. Ordinate: direction and magnitude of deviation of mean diameter relative to initial value.

be related to the diameter of the microvessels. In all animals, the first response to the reduced blood flow was dilatation of the small arterioles and constriction of the large arterioles in the LMB. By contrast, in the RMB the small arterioles were constricted and the large arterioles dilated. The RMB venules displayed a "mosaic" reaction relative to diameter; however, it can be assumed that the smallest and the largest venules dilate (not shown).

Our findings indicate that further studies of postischemic disorders in the blood vessels of paired structures are necessary. It can be postulated that the inflow and outflow components in symmetrical organs bear different functional loads, so that inflow is preserved on the left side and outflow on the right. The more pronounced differences manifested by the microvessels providing inflow in the RMB and LMB may reflect a greater independence of the inflows of symmetrical vascular beds.

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