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Responses of Microvasculature in the Paired Cheek Pouches of Hamsters to Blood Loss and Blood Substitution

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Comparison of arteriolar and venular responses in the left and right cheek pouches of hamsters to blood loss and blood substitution showed that blood loss led to a greater constriction of arterioles and venules in the right pouch than in the left and that blood substitution decreased arteriolar constriction and restored venular size in the right pouch, but resulted in a more marked constriction of both arterioles and venules in the left pouch.

Key Words: *microvasculature; morphometry; blood loss; blood substitution; asymmetry*

Our study of microvascular beds in the paired auricular conchae of rabbits revealed differential responses of these symmetrical vascular beds to blood substitution (BS) [3]; whereas a reduced number of perfused vessels and their constriction were observed in the left concha, dilated vessels with no change in the length of the vascular bed were seen in the right concha. No attempt was made in that study to detect differences between arteriolar and venular responses to BS, although there are grounds for believing that both arteriolar and venular responses are specific on each side [4]. As was found in a study of microvasculature in the hamster cheek pouch after blood loss (BL) and BS [6], arterioles more than 40 μ in diameter responded to BL by constriction and those with larger diameters by dilation (in the presence of reduced blood flow), whereas venules remained unchanged; also, BS with normotonic NaCl solution maintained the state of microvasculature induced by hemorrhage, while BS with hypertonic NaCl solution intensified the arteriolar response and caused venular constriction. The purpose of the present study was to identify and compare arteriolar and venular responses to BL and BS in the symmetrical cheek pouches of hamsters.

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MATERIALS AND METHODS

The study was conducted on 12 Nembutal-anesthetized (9 mg/100 g body weight) hamsters weighing 140-180 g. Biomicroscopic examination of the microvascular beds in their cheek pouches was performed at a magnification of 63 using the conventional method of transparent chambers [5] and a light guide to illuminate the field of vision. To bleed the animals and substitute their blood with isotonic or hypertonic NaCl solution, a catheter was inserted into the femoral artery on the side of biomicroscopy. The amount of blood removed was 25-30% (not more than 2 ml/100 g body weight). Arterioles and venules were photographed (after applying a transparent chamber) before and after BL and BS. The images of microvascular bed fragments were then used to obtain projections of microvessels and estimate their morphometric parameters (area, length, and diameter) [1]. The significance of differences was evaluated by Student's test for conjugated pairs and Student's t test.

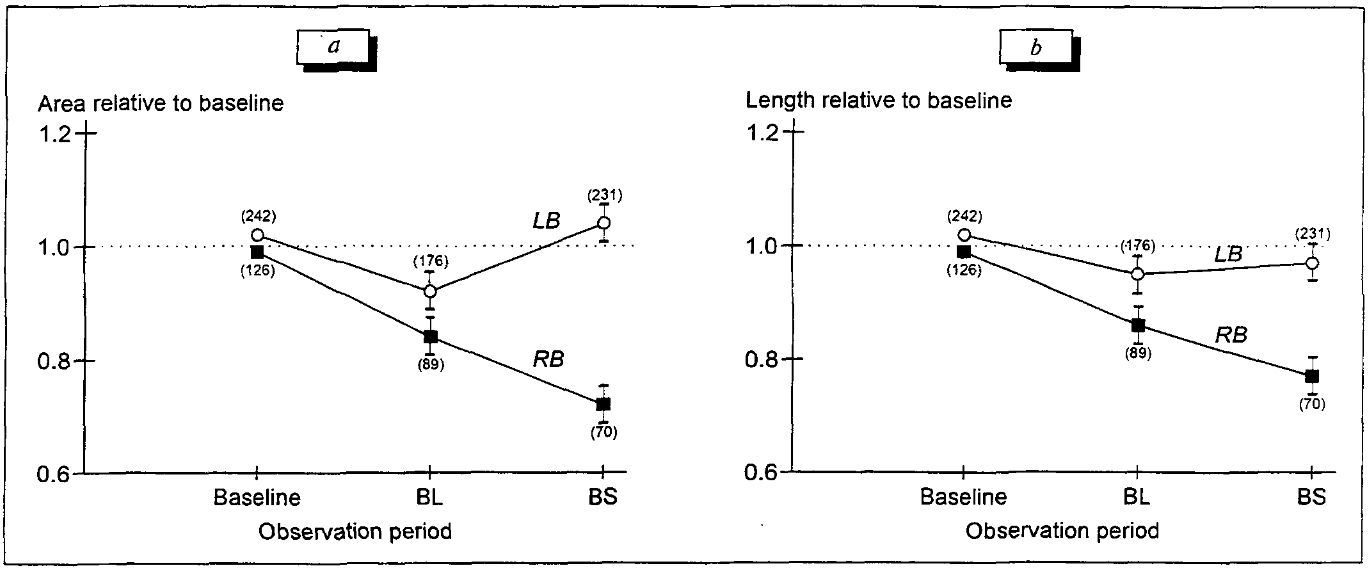

Fig. 1. Variations in the area (*a*) and length (*b*) of microvessels in the paired cheek pouches of hamsters after blood loss (*BL*) and blood substitution (*BS*). *Baseline*: after application of the transparent chamber. Figures in parentheses are the numbers of vascular bed fragments at each point. *LB* = left bed; *RB* = right bed.

RESULTS

As shown in Fig. 1, BL resulted in a reduced area of perfused vessels in both the right and left beds. The decrease on the left was greater than on the right and correlated with the reduction in the number of perfused vessels (with a more marked decrease in their length). BS with the isotonic solution returned the area and length of microvessels to their baseline values in the right bed (its area even exceeded the baseline), but further reduced both the area and length of perfused microvessels in the left bed.

BL led to arteriolar and venular constriction on both sides, though to a greater extent on the right (Fig. 2). After BS, arterioles were less constricted and venules regained their diameter in the right vascular bed, but the constriction of both arterioles and venules became more pronounced in the left bed.

A heterogeneity of microvascular responses similar to that reported previously [6] was also evident in the present study. On the left, the initial mean diameter of arterioles was 38.18±0.17 μ (as calculated for 53 arterioles from 32 left bed fragments) and that of venules 64.45±0.30 μ (48 venules). The respective figures on the right were 44.06±0.23 μ (59 arte-

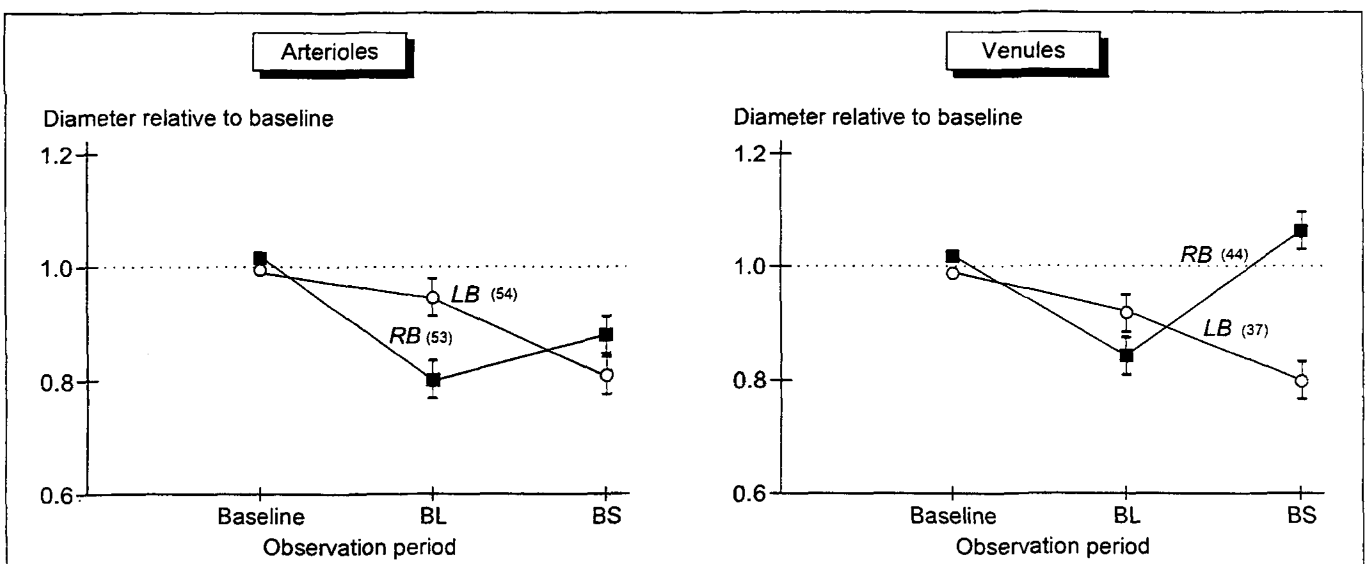

Fig. 2. Variations in the diameter of microvessels in the paired cheek pouches of hamsters after blood loss (*BL*) and blood substitution (*BS*). *Baseline*: after application of the transparent chamber. Figures in parentheses are the numbers of vessels at each point. *LB* = left bed; *RB* = right bed.

rioles) and 89.18±0.46 μ (63 venules). The arterioles and venules that came into view ranged in diameter from 20 to 68 μ and from 30 to 110 μ, respectively, in the left bed and from 20 to 92 μ and 40 to 167 μ, respectively, in the right bed.

On the left, arterioles with a diameter >30 μ responded to BL by constriction and smaller arterioles, by dilation. Constriction in a wide range of diameters was also observed for venules on the left, dilation occurring only in the largest venules (>90 μ in diameter). Both arterioles and venules of the left bed responded by further constriction to BS with the isotonic NaCl solution. However, the hypertonic solution improved the blood supply of arterioles and then also of venules in the left bed. In the right bed, by contrast, arterioles >80 μ in diameter responded to this BS by dilation, smaller arterioles by constriction, venules >40 μ in diameter by constriction and those <40 μ by dilation. After BS with the isotonic NaCl solution, large arterioles in the right bed had diameters above baseline values, arterioles <40 μ in diameter remained constricted, and those with diameters between 40 and 80 μ became enlarged without, however, reaching baseline values. BS thus appeared to have abolished the state of constriction in larger arterioles of the right bed. Venules of this bed exhibited a kind of "mosaicism" in their responses to BS: groups of vessels that had regained their original size alternated with groups remaining in the constricted state, although the overall venular response to BS was determined by the dilation of the larger vessels (>90 μ).

The greater decreases detected in the number of perfused vessels on the left and in their diameter on the right after BL shed light on the physiological essence of bloodletting as an age-old preventive and therapeutic measure, given what is known about the physiological characteristics of vessels on the right and left sides [2]. The observation that the outcome of BS in the right vascular bed is not the same as that in the left bed calls for a differential approach to the selection of blood substitutes to correct microcirculatory disorderson the left and right sides.

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