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Effects of Extracorporeal Circulation and Membrane Contact on Skeletal Muscle Microcirculation in a Rat Dialysis Model

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Objectives : Hemodialysis involves non-physiological processes such as extracorporeal circulation and blood contact with dialysis membranes, which may impair organ microcirculation. However, quantitative in vivo assessments remain limited. Using a previously established rat dialysis model that enables direct observation of tibialis anterior (TA) muscle surface blood flow, this study aimed to quantitatively evaluate the effects of extracorporeal circulation and membrane contact on microcirculation by analyzing red blood cell (RBC) velocity.
Methods : Rats were assigned to three groups: Sham (no extracorporeal circulation), extracorporeal circulation (ECC; blood circulated through a blood circuit only), and membrane-contact (blood circulated through a blood circuit and dialysis membrane). TA surface blood flow was recorded using videocapillaroscopy at baseline and up to 240 minutes after the initiation of circulation. Three capillaries per rat were analyzed, and RBC velocity was calculated by tracking individual RBCs. Values were normalized to baseline, and percentage changes in RBC velocity were calculated. The velocity changes at 0, 30, and 60 minutes were further categorized in 25% increments to assess heterogeneity.
Results : In both the ECC and membrane-contact groups, RBC velocity decreased to approximately 30% of baseline at 30 minutes and did not recover thereafter. In contrast, the Sham group showed an approximate 40% increase from baseline. The proportion of capillaries with severe velocity reduction (≤25% of baseline) was 77 and 66% at 30 and 60 minutes, respectively, in the membrane-contact group, and 40 and 60%, respectively, in the ECC group. No severe reductions were observed in the Sham group.
Conclusions : Extracorporeal circulation and dialysis membrane contact reduced capillary RBC velocity and increase flow heterogeneity in skeletal muscle microcirculation, suggesting impaired oxygen delivery to tissue during hemodialysis.