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Dynamics of RBCs under shear flow in sickle cell disease. A tool for monitoring the clinical state of patients.[1] EMMANUELE HELFER, MAXIME SAHUN, SCOTT ATWELL, ALEXANDER HORNUNG, ANNE CHARRIER, ANNIE VIALLAT, Aix Marseille Univ, CNRS CINaM, CATHERINE BADENS, Aix Marseille Univ, INSERM, MMG — The regimes of motion of red blood cells (RBCs) under shear flow have been extensively studied because they directly relate to the cell mechanical properties. In addition to tumbling and tank-treading motions, other regimes were recently discovered, such as swinging, flip-flopping, and rolling. Computational studies provide complex phase diagrams of motion that depend on the ratio of RBC cytoplasm to external fluid viscosities and on the capillary number. Surprisingly, no experiments have been performed on RBCs from patients with sickle cell disease (SCD) which have altered mechanical properties. Here, we show that the dynamics of SCD-RBCs is modified and correlates with change in RBC density and state of hydration. Though the tumbling - flip-flopping – rolling path observed by increasing shear rate is not changed for SCD, the rolling to tanktreading threshold occurs at higher shear stress. We use this feature to propose a mechanical marker, namely the fraction of tanktreading RBCs in a large cell population, to follow the clinical state of SCD patients and to predict the very handicapping vaso-occlusive crises. We show that this marker is patient-dependent and is stable over time in the "out of crisis" period while it strongly varies during the course of a crisis.

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