Short-term and repeated shear stress exposure below the classic haemolytic threshold impairs red blood cell deformability and induces haemolysis

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The supraphysiological shear stress (SS) red blood cells (RBC) are exposed to while traversing circulatory assist devices (CAD) impairs RBC deformability and may lead to haemolysis. Although exposure time to supraphysiological SS within CAD is limited, the magnitude of SS is crucial to the amount of damage to RBC [1, 2]. We explored changes in RBC function following exposure to SS below the reported “haemolytic threshold” with a duty-cycle typical of that employed by CAD. Blood collected from 20 male donors, aged 18–38 yr, was suspended in a viscous medium and exposed to a SS protocol of 1 s, at 100Pa, every 60 s for 60 duty-cycles. An ektacytometer was used to measure RBC deformability after each exposure. Haemolysis was quantified via spectrophotometry. The mechanical SS protocol impaired RBC function as indicated by: (1) significant shifts in the RBC dynamic morphological response to SS, after 15 duty-cycles; and (2) increased incidence of haemolysis following 60 duty-cycles. The present study demonstrates exposure of RBC to short-term, repeated supraphysiological SS, impairs RBC deformability, with each duty-cycle causing an increase in RBC rigidity that ultimately precipitates haemolysis.