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Fibrin matrices dissolution enhanced by self-assembling magnetic colloid's actuation

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An ischemic stroke, characterized by the interruption of blood flow in the brain, occurs when a blood clot forms within a vessel. To enhance the drug treatment's duration, we introduced a vector to deliver the thrombolytic drug toward the thrombus'site. Indeed, rotating rod-like aggregates composed of multicore magnetic nanoparticles can generate a recirculation flow that convectively diffuses the drug along the blocked vessel (Fig. 1a). In this work, we conducted fibrin matrices dissolution experiments by synthetizing *in vitro* model clots from pig plasma at one end of a microfluidic channel, to represent an occluded blood vessel. The other part was filled with a suspension of polymer-coated multicore iron oxide nanoparticles in pig plasma with tissue plasminogen activator (tPA), the dissolution agent. The microfluidic device was then placed at the center of a three coils system powered by alternating current, allowing us to produce a superposition of a rotating magnetic field and a magnetic field gradient. This configuration enables the nanoparticles to assemble into micro-sized elongated aggregates oriented along the field's direction and produces a gradient of their concentration across the channel (Fig. 1b) [1]. The aggregates then rotate synchronously with the field, translate due to their interaction with the channel's wall and generate a macroscopic recirculation flow [2]. Their geometry and volume fraction were measured by image analysis. With this method, we were able to observe a clear dissolution front and study its displacement (Fig. 1c). The aggregates'actuation allowed a lysis speed ~10 times higher than the tPA passive diffusion lysis speed. This study shows promising results for clot lysis treatment by enhanced thrombolytic drug convection along a blocked blood vessel.

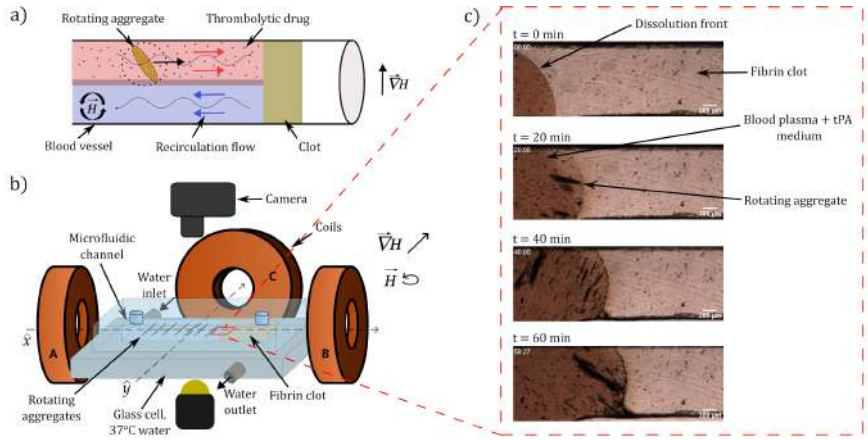

Figure 1: a) Sketch of the problem: drug convection along an occluded blood vessel. b) Experimental setup. c) Kinetics of dissolution of a fibrin matrix in a microfluidic channel, enhanced by rotating aggregates.

References

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[2] J. Queiros Campos, M. Raboisson-Michel, S. Schaub, S. Toe, L. Boulant, G. Verger-Dubois, A. Zubarev, and P. Kuzhir. Field-Induced Macroscopic Flow of a Dilute Self-Assembling Magnetic Colloid under Rotating Magnetic Fields. *Journal of Fluid Mechanics.* 981, A11 (2024).

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