Cold atmospheric plasma for mild blood coagulation in visceral surgery

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In surgery, blood vessel injury is inevitably and therefore an efficient haemostasis is essential to minimize blood loss. By necrotizing healthy tissue, thermal coagulation is a frequently used but also a harsh method to limit bleeding [1, 2]. Moreover, increasing prescriptions of new oral anticoagulants compromise efficient bleeding management of emergency patients [3]. Thus, the development of new mild and tissue tolerable coagulation methods is necessary. A dielectric barrier discharge plasma has previously been suggested to be haemostatically effective [4] and we would like to extend on this by using an atmospheric pressure argon plasma jet (kINPen MED) here . Citrate-anti-coagulated blood or its platelet isolates from C57BL/6 mice was exposed *ex vivo* to plasma (CAP) or argon gas alone, or was left untreated. Platelet activation, a marker of haemostasis, was investigated using flow cytometry. In platelet isolates, we observed a significantly increased CD62P-expression in plasma but not argon samples. In murine whole blood, however, this finding could not be confirmed although clotting was present to a much greater extend in plasma compared to argon treated samples (Fig. 1.). Blood coagulation is not only present on the cellular but also on the protein level and accordingly we investigated the degradation of fibrinogen to fibrin concurring with haemostasis. A significant change was not observable. It follows that blood coagulation *ex vivo* and using the kINPen MED was visually present but we were not able to identify the mechanism of action. The biological relevance of the *ex vivo* results were further investigated in an *in vivo* mouse model of clotting during simulated visceral liver incision surgery. The efficacy of cold plasma, electric cauterization, argon gas treatment were compared in control as well as in Rivaroxaban or Clopidogrel anti-coagulated animals to investigate whether cold plasma may improve coagulation management in anti-coagulated patients in future.

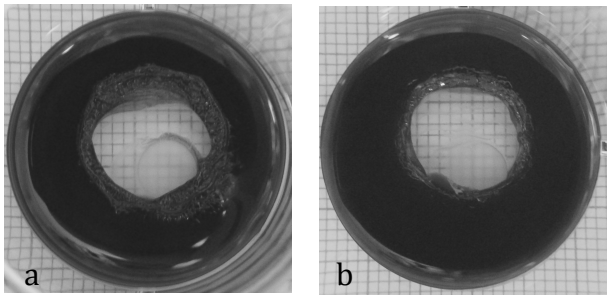

Fig. 1. Blood samples after treatment with cold atmospheric plasma (a) or argon gas (b). The whole in the sample is due to the gas flow. Blood coagulates in the surroundings.

References

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