Plasma characterization of an argon plasma coagulation (APC) system with oxygen admixture in low amount

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Argon plasma coagulation (APC) is a surgical technology to treat biological tissue with an argon discharge at atmospheric-pressure conditions.
During surgical application of APC, oxygen is present everywhere, especially in the ambient air. This ambient oxygen is able to diffuse into the APC discharge, to form negative ions, and to influence thereby the APC discharge.
Currently, the impact of negative ions influencing the degree of the APC discharge is not known.
Therefore, our aim is to investigate the plasma parameters for an APC application dependent on the existence of negative ions by various concentration of oxygen admixture to the plasma gas argon on biological tissue.

For this characterization of the plasma parameters, like electron density and electric field, we used optical emission spectroscopy (OES), current-voltage measurements, microphotography, and numerical simulations.
Whereby, we ignited the APC plasma with a high frequency generator (ERBE VIO 300 D, ERBE Elektromedizin GmbH, Tuebingen) and an APC 2 unit (ERBE Elektromedizin GmbH, Tuebingen). The plasma gas was an argon-oxygen admixture (1 slm argon + 0.005, 0.01, 0.05, 0.1 slm oxygen) that flows through a flexible APC probe with an outer diameter of 2.3 mm, an inner diameter of 1.5mm, and a length of 2.2 m (ERBE Elektromedizin GmbH, Tuebingen). The ignited plasma discharges were applied on porcine kidney in a distance of 2 mm between the tissue surface and the APC probe.

Our investigations showed that the admixture of oxygen to the plasma affects especially the size of electric field that is necessary to ignite the APC discharge.
The higher the admixture of oxygen to the plasma gas, the higher is the electric field value, necessary for plasma ignition.
Furthermore, we confirmed that existence of oxygen in higher concentrations results in more tissue damage, especially carbonization of the tissue surface.

With the characterization of the plasma parameters of an argon plasma discharge with a low admixture of oxygen, we concluded that a low, respectively non oxygen existence has the best conditions for plasma ignition with low electric field and less carbonization of the treated tissue.