Treatment of Diseases by Inhalation of Atmospheric Pressure Plasma Flow

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Recently, atmospheric-pressure plasmas are indispensable for sterilizing, disinfecting, decomposing hazardous materials and modifying material surfaces and new biomedical applications have also been found although the mechanisms of action remain unknown. Plasmas contain many neutral molecules, ions, and radicals and oxidative nitrogen compounds such as Nitric oxide (NO) are generated under atmospheric conditions. NO in mammals including humans is an important cellular signaling molecule for many physiological and pathological processes. Especially, NO inhalation is used to treat persistent pulmonary hypertension of the newborn, heart load reduction during open-heart surgery and primary pulmonary hypertension. We aimed to distinguish endogenous and exogenous NO in a porcine model pulmonary of hypertension to clarify the relationship between NO concentration in the bloodstream and hypote nsion.

A schematic diagram of the experimental setup is shown in Figure 1. The coaxial plasma source has a 1-mm-diameter tungsten wire inside a glass capillary, that is surrounded by a grounded tubular electrode. The AC/DC amplifier and multifunction synthesizer controlled by PC provides a high voltage for plasma generation. Plasma was generated under the following conditions: applied voltage, 8 kVpp; frequency, 3 kHz; helium (He) gas flow rate, 1 L/min. On the other hand, sphygmomanometry of a blood vessel proceeded using a device comprising a disposable force transducer, a bedside monitor for simultaneous electrocardiography and signal pressure measurements, and a pressure pack containing physiological saline to adjust the pressure in the catheter. We directly measured NO using a catheter-type NO sensor placed in the coronary sinus through an angiography catheter from the abdomen. The mini pig (weight: 10–15 kg) were initially sedated with ketamine and anesthetized with sevoflurane using an anesthesia device with a mechanical respirator.

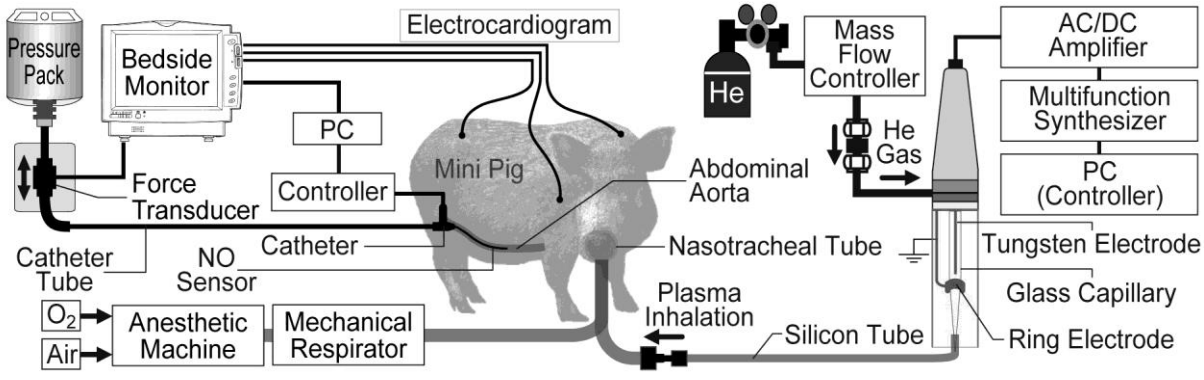

Figure 1: *Experimental setup*

According to the NO concentration in the abdominal aorta as a function of the duration of plasma inhalation, the NO concentration started to increase from 10 s, reached a maximum value at about 40 s and then gradually decreased. In addition, from the results of blood pressure in the abdominal aorta after inhaling He gas and plasma, blood pressure did not decrease while inhaling He, but decreased from 110/65 to 90/40 mm Hg after inhaling plasma. Blood pressure started to fall about 10 s from starting inhalation, and reached the nadir 40–50 s later. The results of the present study are very similar to those obtained by other groups that used a catheter-type NO sensor to determine the acute or chronic effects of angiotensin II on the bioavailability of NO in rabbits.