Verification of assumptions of volume-clamp method continuous blood pressure measurement in a silicone phantom

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The volume-clamp method allows continuous blood pressure monitoring with a finger cuff. During measurement, a constant volume of a finger is maintained. The changes in diameter are measured with a photodiode and infrared LED built-in cuff. Changes in volume caused by the change in finger artery blood pressure are compensated with changes in cuff pressure. At a valid set-point, blood pressure and cuff pressure equality are assumed during measurements. In this paper, we verified this assumption in the phantom experiment.

In the study, the silicone cylindric phantom was used. For measurements of changes in diameter, we used a pulse oximeter sonde with a dedicated amplifier with analog voltage output. The finger cuff was placed over the phantom. We observed changes in voltage caused by applied pressure in two scenarios: first, when pressure was applied only to the inner cylinder, and second when the same pressure was applied to the inner cylinder and the cuff.

In the first scenario, pressure greater than 40mmHg volume increases proportionally to the inner pressure increase. When applying equal pressure to the cuff and inner of the cylinder, measured increase voltage for pressure below 120mmHg, stabilize in the range of 100-160mmHg, and for larger pressure, measured voltage decrees.

In both cases, the attenuation is a function of inner pressure. This observation is in contradiction to the assumption of the methods. The pressure in the cuff alters the nature of the phantom light attenuation function. To maintain the constant volume of the phantom, a different level of inner and outer pressure should be applied.

However, observations are constrained by the limitation of the model. The attenuation function for a real finger may be significantly different than that in a silicone phantom.