

Article

Hydroxyethyl Starch, a Synthetic Colloid Used to Restore Blood Volume, Attenuates Shear-Induced Distortion but Accelerates the Convection of Sodium Hyaluronic Acid

Tsuneo Tatara

Department of Anesthesiology, School of Medicine, Hyogo Medical University, 1-1 Mukogawa-cho, Nishinomiya, Hyogo 663-8501, Japan; ttatara@hyo-med.ac.jp

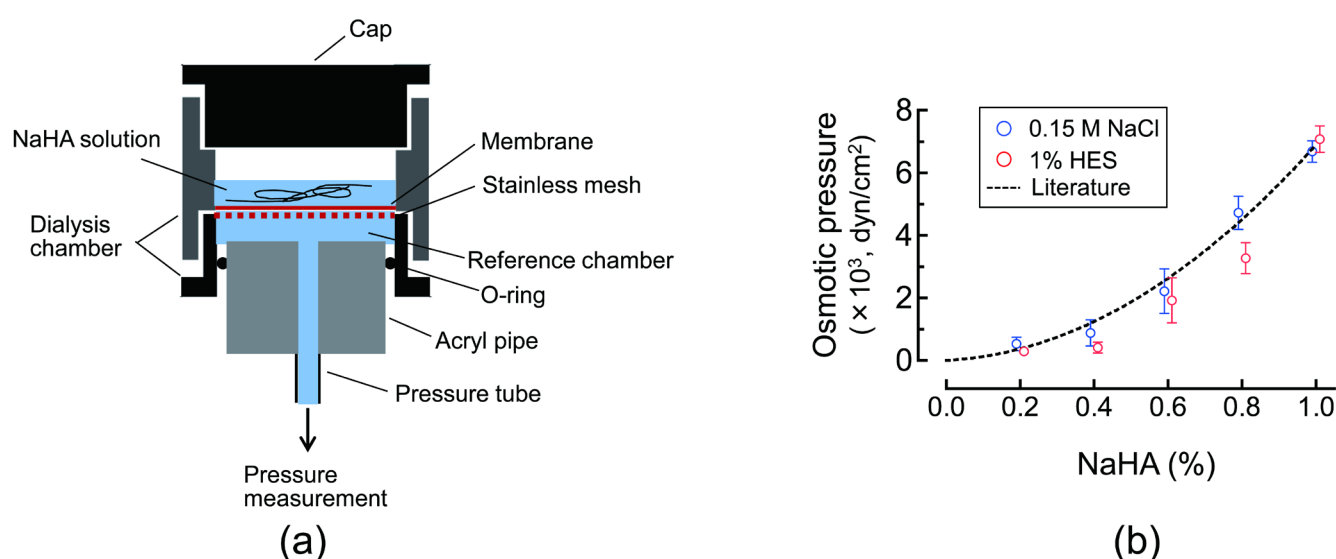


Figure S1. (a) Schematic of osmotic pressure measurement of sodium hyaluronic acid (NaHA) solution. The osmotic pressure of NaHA solution was measured using a fast micro-equilibrium dialyzer™ (outer diameter 2.5 cm, chamber volume 1000 μ L: 7416-10001D, Harvard Apparatus, Holliston, MA, USA) equipped with an end cap with a hole (74-1116, Harvard Apparatus, Holliston, MA, USA). Two fluid chambers are separated by a semipermeable cellulose acetate membrane (molecular weight cut-off, 300,000; 7415-CA300K, MWCO: 300,000) attached to a stainless mesh, with one of the chambers serving as the sample chamber (filled with 0.5 mL NaHA solution) and the other as the reference chamber (filled with 0.15 M NaCl solution or 1% hydroxyethyl starch [HES] solution), which is connected via a narrow channel (0.5 mm diameter) to a manometric chamber fitted with an electronic pressure transducer (PGM-02KG, Kyowa, Tokyo, Japan). Fluid movement from the reference chamber toward the sample chamber due to the osmotic swelling force of NaHA solution creates negative hydrostatic pressure in the reference chamber, which equals the osmotic pressure of NaHA solution against test solutions in the reference chamber. Equilibrium of hydrostatic pressure in the reference chamber was reached within 72 hrs. (b) Comparison of osmotic pressure for sodium hyaluronic acid solution against 0.15 M NaCl solution or 1% hydroxyethyl starch (HES) solution. The dotted line denotes osmotic pressure for sodium hyaluronic acid solution of $M_w 1.5 \times 10^6$ in phosphate buffered saline calculated from the literature [20]. Experiments were carried out at 25°C. Values are expressed as mean and standard error ($n = 5$). Osmotic pressure of NaHA dissolved in 0.15 M NaCl solution was similar to that reported in the literature [20] and 1% HES did not significantly change the osmotic pressure of NaHA solution.

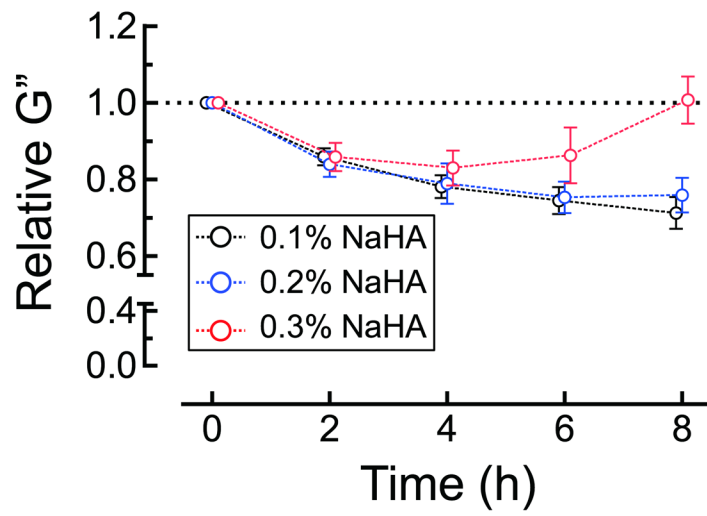


Figure S2. Time-course changes in loss shear moduli (G'') of sodium hyaluronic acid (NaHA) of different concentrations dissolved in 0.15 M NaCl solution at 0.36 Hz during shear stress loading at the rate of 0.1 s^{-1} relative to before shear stress loading. Experiments were carried out at 37°C . Values are expressed as mean and standard deviation ($n = 11$ [0.1% NaHA] or 8 [0.2%, 0.3% NaHA]).