Supplementary information

Evaluating thrombosis risk and patient-specific treatment strategy using an atherothrombosis-on-chip model

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Flow rate calculation for mimicking physiological shear rate in the device

The flow rate was calculated by using the following equation:

To convert the arterial shear rate (1,000 s^{-1}) into flow rate, we used Newton's law of viscosity.

Briefly,

Newton's law of viscosity:

$$\tau = \eta \times \frac{dv}{dx}$$

Where,

τ = shear stress

η= viscosity (Pa.s)

$\frac{dv}{dx}$ = shear rate (s^{-1})

dyn/cm^2 is often used as dynamic viscosity unit instead of Pa.s in the cardiovascular system.

Since 1 Pa = 10 dyn.s/cm^2,

The dynamic viscosity of the blood = 3×10^{-3} Pa.s

$= 3 \times 10^{-2}$ dyn.s/cm^2

Since the shear rate is 1,000 s^{-1} , the shear stress is calculated as,

$\tau = 3 \times 10^{-2}$ dyn.s/cm^2 $\times 1{,}000$ s^{-1}

$= 30$ dyn/cm^2 … … … … (1)

The shear stress was calculated using the following equation [1-4]

$$\tau = \frac{6\eta Q}{h^2 w} \quad \dots \dots \dots \dots (2)$$

Here,

τ: shear stress

h: height of the channel= 50 µm= 0.005 cm

w: width of the channel= 200 µm= 0.02 cm

η: dynamic viscosity of the blood (dyn.s/cm^2) = 3×10^{-2} dyn.s/cm^2

Q: Flow rate

By rearranging equation 2 and taking the value from equation 1,

$$Q = \frac{\tau(h^2 w)}{6\eta} = \frac{30\ dyn/cm^2\ (0.005)^2\ cm^2\ x\ 0.02cm}{6\ (\ 3\ x\ 10^{-2}\ \frac{dyn.s}{cm^2})} = 8.33 \text{ x } 10^{-5}\ \text{cm}^3/\text{s}$$

We know, $1\ cm^3 = 1\ mL$,

$Q = 8.33 \times 10^{-5}\ cm^3/s = 8.33 \times 10^{-5}\ ml/s = 4.998\ \mu L/min$