Fluid Mechanics of Arteriosclerotic Obstructions and Arterial Bypasses

ME 241 Fluid Mechanics Final Project

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Research Question

How is blood flow rate through coronary arteries affected by arteriosclerotic obstructions and arterial bypasses inserted to relieve it?
Methodology

- Assumptions
  - Steady laminar flow
  - Conservation of mass

- Poiseuille’s law

\[ Q = \frac{\Delta P}{8\mu L} \]

\[ R = \frac{8\mu L}{\pi D^4} \]
Methodology

\[
\frac{Q_a}{Q} = \frac{1}{1 + \frac{r_{ba}^4}{l_{ba}} \left( 1 + \frac{l_{oa}}{r_{oa}^2} \right)}
\]

\[
\frac{r_{ba}^4}{l_{ba}} = \frac{\left( \frac{Q}{Q_a} - 1 \right)}{\left( 1 + \frac{l_{oa}}{r_{oa}^2} \right)}
\]

\[
r_{ba} = \frac{r_B}{r_a} \quad l_{ba} = \frac{L_B}{L_a}
\]
Results

\[ r_a = 5 \text{ mm} \]
\[ l_a = 50 \text{ mm} \]
\[ r_o = 2.5 \text{ mm} \]
\[ l_o = 10 \text{ mm} \]
\[ r_b = 5 \text{ mm} \]

\[ \frac{r_b^4}{l_{ba}} = \frac{\left( \frac{Q}{Q_a} - 1 \right)}{\left( 1 + \frac{l_{oa}}{r_o^4} \right)} \]
Results

\[ r_a = 5 \text{ mm} \]
\[ l_a = 50 \text{ mm} \]
\[ r_o = 2.5 \text{ mm} \]
\[ l_o = 10 \text{ mm} \]
\[ l_b = 100 \text{ mm} \]

\[
\frac{r_{ba}}{l_{ba}} = \left( \frac{Q}{Q_a} - 1 \right) \left( 1 + \frac{l_{aa}}{r_o^4} \right)
\]
Conclusion

- Problems in investigation
  - Complexity of blood flow

- Two main factors affecting the blood flow rate through an arterial bypass
  - Radius of the graft
  - Length of the graft

- Effect of radius $>>$ length