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## Sequential Bypass Effects in the Stenosed Coronary Artery

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Key Words: Coronary Artery( ), Sequential Anastomosis( ), Numerical Analysis ( ), Mass Flow Rate( ), Hemodynamic Characteristics ( )

### Abstract

Bypass anastomosis are frequently adopted for surgical treatments. After the bypass grafting, the bypass artery is often occluded due to restenosis and/or anastomotic neointimal fibrous hyperplasia phenomena. Optimal coronary bypass anastomosis should be investigated to improve the patency for the arterial bypass techniques. The objective of this study is to investigate the influence of bypass with sequential bypass effects in the stenosed coronary artery. Numerical analyses are focused on the understanding of the flow patterns for different sequential anastomosis techniques. Blood flow field is treated as two-dimensional incompressible laminar flow. The finite volume method is adopted for discretization of the governing equations. The Carreau model is employed as the constitutive equation for blood. To find the optimal sequential bypass anastomotic configurations, the mass flow rates at the outlet of different models are compared quantitatively.

1.

Suh Roh '97, '98  
가 Aorto-coronary bypass  
(3,4) aorto-coronary bypass  
aorto-coronary  
bypass

(1,2)

가 가  
sequential bypass 2

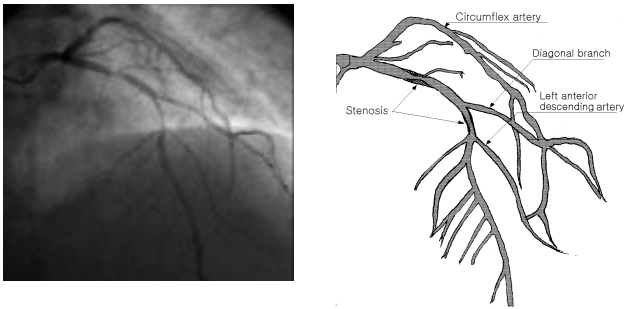
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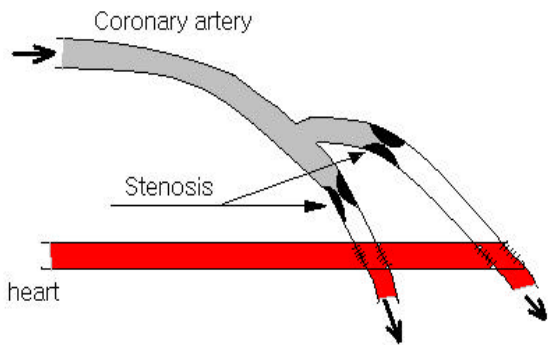
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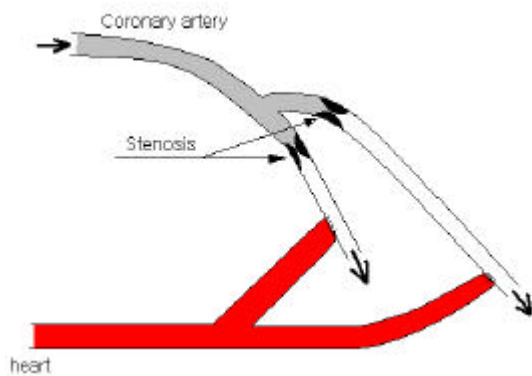


(a) Angiogram (b) schematic diagram

Fig. 1 Angiogram and schematic diagram of the left coronary artery with stenoses



(a) non-bifurcated model



(b) bifurcated model

Fig. 2. Examples of the sequential anastomotic bypass

2.

Fig. 1

가

Fig. 2 (a)

side-to-side,

end-to-side

Fig. 2(b)

2

end-to-side

3.

4)

$$\frac{\partial u_j}{\partial x_j} = 0 \tag{1}$$

$$\rho u_j \frac{\partial u_j}{\partial x_j} = -\frac{\partial p}{\partial x_j} + \frac{\partial \tau_{ij}}{\partial x_j} \tag{2}$$

(1) (2)

$u_i, p, \rho, \tau_{ij}$

(2)

(3)

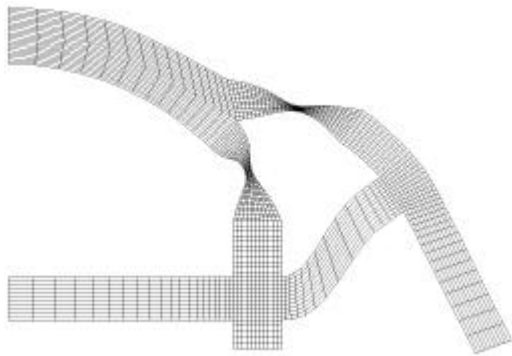
$$\tau_{ij} = \eta \left( \frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} \right) \tag{3}$$

(4)

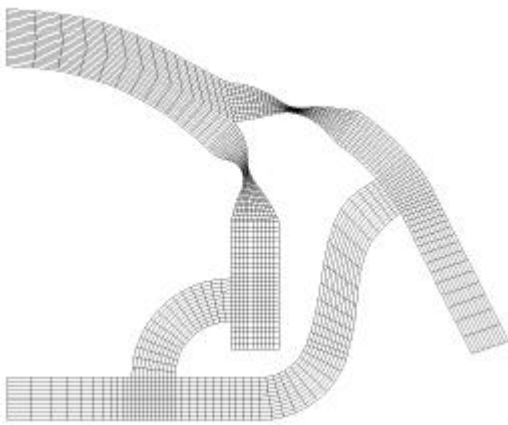
Carreau

5)

$$\eta = \eta_\infty + (\eta_0 - \eta_\infty) [1 + (\lambda \dot{\gamma})^2]^{-\frac{(n-1)}{2}} \tag{4}$$



(a) non-bifurcated model



(b) bifurcated model

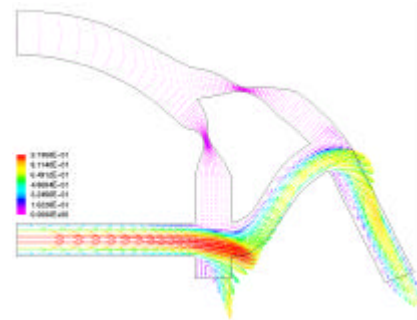
Fig. 3. Two-dimensional meshes for the sequential bypass model

(FVM)

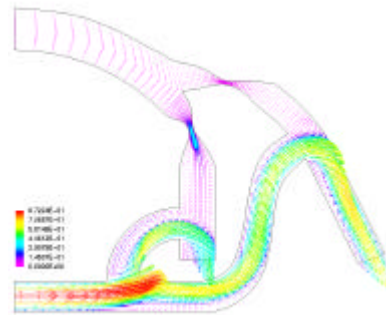
가  $1 \times 10^{-6}$

Fig. 3

4.

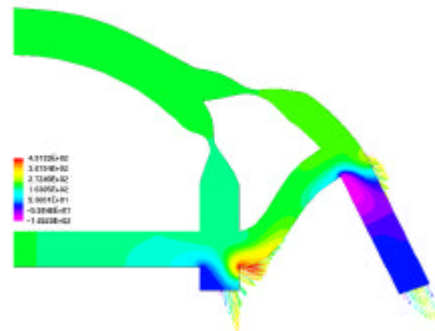


(a) non-bifurcated model

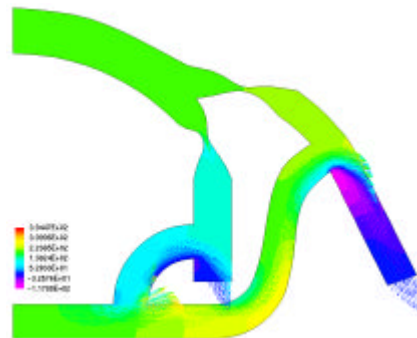


(b) bifurcated model

Fig. 4 Velocity vectors after the bypass grafting in the stenosed coronary



(a) non-bifurcated model

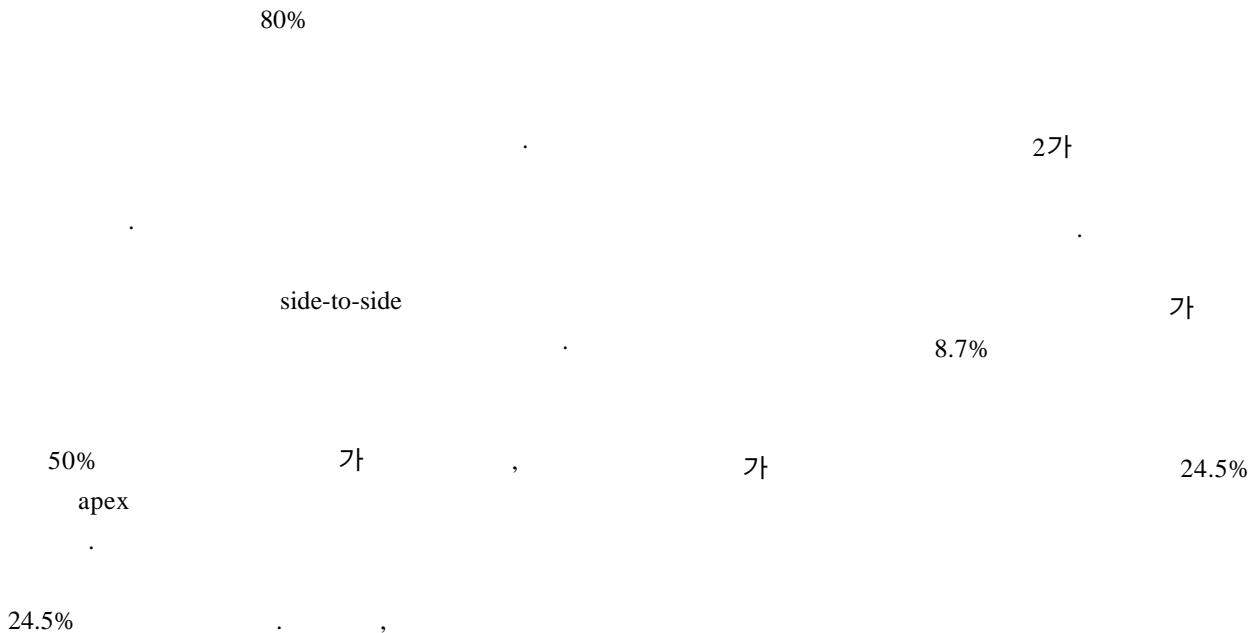


(b) bifurcated model

Fig. 5 Pressure shade contours after the bypass grafting in the stenosed coronary artery

Fig. 4 Fig. 5

Fig. 4



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2가

Table 1 Fig. 4

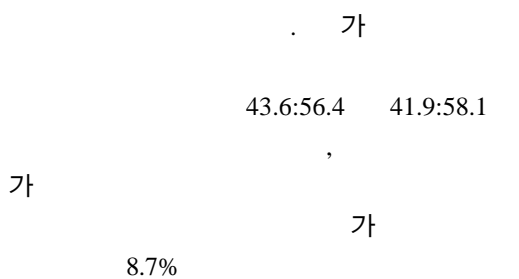


Table 1 Comparison of mass flow rate(g/s)

	Inlet		Outlet		total
	Coronary artery Side	Aorto artery side	Anterior artery side	Diagonal artery side	
non-bifurcated model	0.0784	8.432	3.718 (43.6%)	4.791 (56.4%)	8.509 (100%)
bifurcated model	0.414	7.413	3.279 (41.9%)	4.548 (58.1%)	7.827 (100%)

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