Optimal multiplanar mechanical aortic valve

Optimal çok düzlemli mekanik aort kapağı

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In stented valves, appropriate valve size regarding the body surface area has been defined by David et al. (1). Some studies have been published related to multiplanar mechanical aortic valve developed in order to overcome the problem of pressure gradient in stented valves (2, 3). It has been shown that multiplanar aortic valve could overcome the problem of pressure gradient in stented valves. In this study, mathematical solutions showing how to optimize a multiplanar valve to increase the orifice area were shown with the aid of illustrations (Fig. 1-6).

Multiplanar aortic valve aims to increase the effective orifice area via protruding its leaflet stent or stents into ascending aorta instead of aortic annulus. Coronary orifices are mostly two in number and this valve also permits these orifices to remain open during both systole and diastole. The area scanned by the leaflet from its closed state (seated on stent) to the maximally opened state is called as scanned area. The area constituted by the inner side of the stent is called as orifice area.

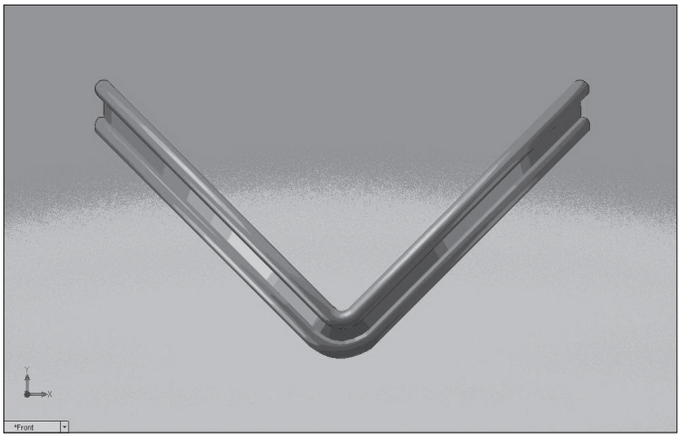

Figure 2. Optimal multiplanned valve's aspect from lateral side, closed leaflet

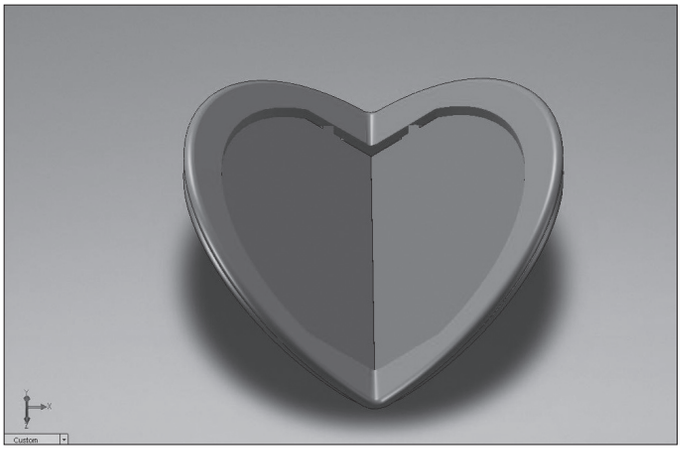

Figure 1. Optimal multiplanned valve's aspect from aortic side, closed leaflet

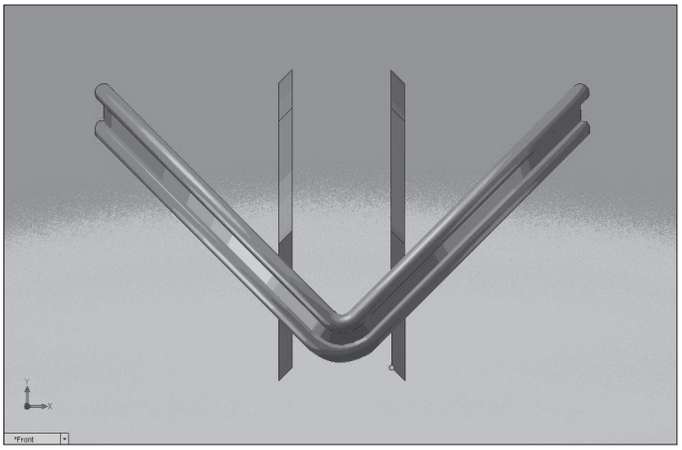

Figure 3. Optimal multiplanned valve's aspect from lateral side, open leaflet

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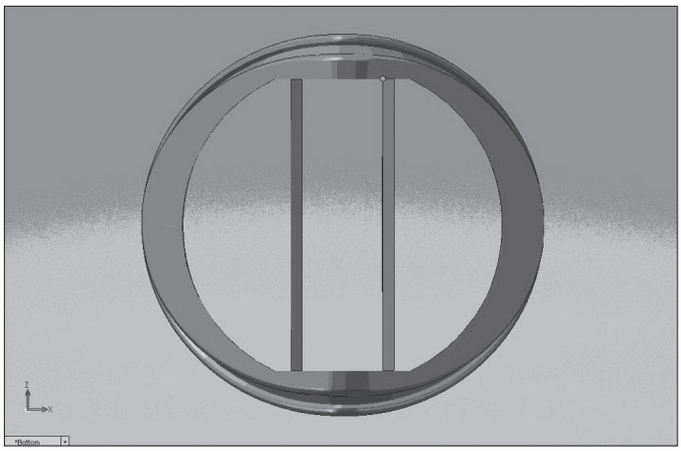

Figure 4. Optimal multiplanned valve's aspect from ventricle side, open leaflet

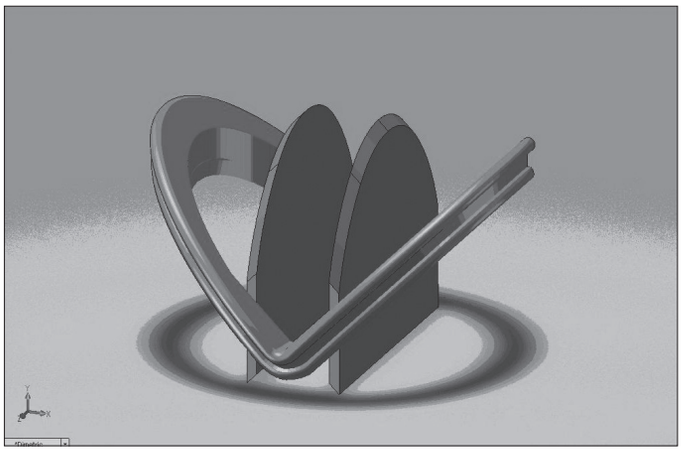

Figure 5. Optimal multiplanned valve's aspect from lateral side, open leaflet

In recently used bileaflet valves, assuming the inner diameter of the valve as 2 centimeters, orifice area will be calculated as 3.14 cm^2 (since the radius is 1 cm). When the leaflets open with an angle of 90°, scanned area by both leaflets will be 6 cm^2 (half of the surface area of a sphere with a radius of 1 cm, 4 πr^2).

In order to optimize a multiplanar valve, the angle at where the orifice area formed by the stent equals to the scanned area by the leaflet (the angle between the stent protruding to the ascending aorta and annular plane) should become the angle of optimal multiplanar aortic valve. This angle is 45 degrees and the angle between two leaflet stents will be 90°.

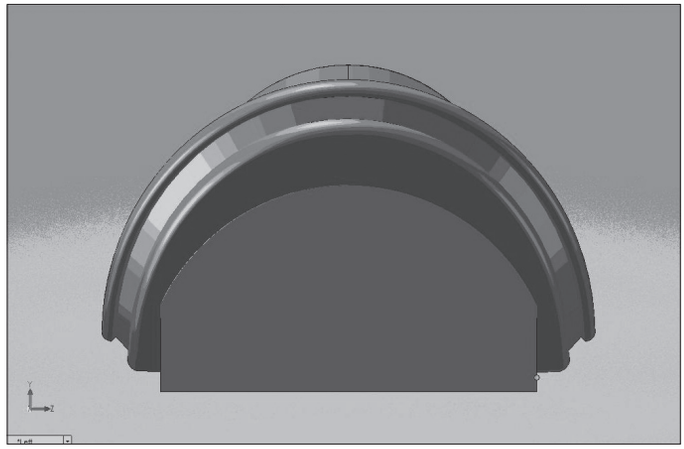

Figure 6. Optimal multiplanned valve's aspect from anterior or posterior side, open leaflet

Multiplanar bileaflet aortic valve is seen in illustrations. Accordingly, the orifice area of a valve placed to an aorta of 2 cm in diameter will be 6 cm^2. Radius of leaflet-when extended 1 cm distally, calculated as the hypothenar side- will be 1.5 centimeters. The area of this leaflet will be calculated as 1.5x1.5x3.14/2 resulted as about 3 cm^2. There are two of these leaflets, making a total of 6 cm^2.

Moreover, this valve will minimize problem of turbulence existing in prosthetic valves at all points via changing the configuration of the valve.

We think that this multiplanar aortic valve would solve problem of pressure gradient and minimize problem of turbulence occurring in stented valves at aortic position.

References

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