Fundamentals of Arterial and Venous Angioplasty

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Disclosure
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Three layers of blood vessel wall
- Intima
- Media
- Adventia

Artery
Vein

Atherosclerosis
Neointimal hyperplasia

Angioplasty = controlled vascular injury
Disruption or dissection of the medial layer is the primary mechanism for endoluminal expansion
Pre-angioplasty

Post-angioplasty

Luminal enlargement due to disruption of blood vessel wall

Minimize the length of balloon within normal vein
Angioplasty damages the venous endothelium and can incite neointimal hyperplasia

Use 4cm length balloon

The length of the angioplasty balloon should extend ~ 5mm beyond the end of the stenosis

The diameter of the angioplasty balloon should be ~ 15% - 20% larger than the diameter of the normal blood vessel adjacent to the stenosis

Measurement using radiographic ruler

Measurement using digital software
Know the tools of your trade

**Anatomy of an Angioplasty Balloon**

Primary selection criteria:
- Length
- Diameter

**Balloon Compliance**

Change in balloon diameter as a function of inflation pressure

<table>
<thead>
<tr>
<th>Balloon</th>
<th>Diameter at nominal pressure</th>
<th>Diameter at rated burst pressure</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.5mm</td>
<td>7.2mm</td>
<td>9.8%</td>
</tr>
<tr>
<td>B</td>
<td>6.8mm</td>
<td>7.0mm</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

Nominal pressure = inflation pressure required to reach specified diameter

Rated Burst Pressure = the pressure at which 99.9% of balloons will survive with 95% confidence

**Balloon Compliance**

- Angioplasty balloons are non-compliant
- Maintain fixed shape and diameter with increasing pressure

Non-compliant balloon: - maintains fixed diameter with increasing pressure
Compliant balloon: - increasing diameter with increasing pressure
The rated burst pressure decreases as the diameter of the balloon increases.

**Law of LaPlace**

The larger the balloon radius, the larger the wall tension exerted.

**Geometry of Balloon Inflation**

Mechanical force of dilation (DF) is greatest at the waist on the balloon.

**Angioplasty Balloon Inflation Pressures**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>&gt;15 atm</th>
<th>&gt;20 atm</th>
<th>&gt;30 atm</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTFE Graft</td>
<td>15.4 atm</td>
<td>53%</td>
<td>9%</td>
<td>1%</td>
</tr>
<tr>
<td>Fistula</td>
<td>15.2 atm</td>
<td>59%</td>
<td>20%</td>
<td>6%</td>
</tr>
</tbody>
</table>
Inflation Pressure

Mean inflation pressure: 17.2 atm

Number of Stenoses

Angioplasty Balloon Inflation Pressures

TM Vesely JVR 2005;17: 623-628

Atherosclerosis Neointimal hyperplasia

4 – 8 atmospheres inflation pressure

15 – 20 atmospheres inflation pressure

Angioplasty Balloon Burst Pressure

Following an angioplasty procedure the PTA balloon was saved and tested to determine the burst pressure

- Centurion
- Blue Max
- Workhorse II
- PowerFlex Extreme
- Conquest

25 balloons of each type were inflated until rupture

Angioplasty Balloon Burst Pressure

7mm and 8mm diameter balloons

<table>
<thead>
<tr>
<th>Balloon Type</th>
<th>Rated BP (atm)</th>
<th>Actual BP (atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workhorse II</td>
<td>16</td>
<td>26.1</td>
</tr>
<tr>
<td>Centurion</td>
<td>20</td>
<td>27.8</td>
</tr>
<tr>
<td>Extreme</td>
<td>20</td>
<td>28.7</td>
</tr>
<tr>
<td>Blue Max</td>
<td>20</td>
<td>&gt;30.0</td>
</tr>
<tr>
<td>Conquest</td>
<td>30</td>
<td>&gt;30.0</td>
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Distribution of Balloon Burst Pressures

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Summary

Measure stenoses

in order to

Select correct diameter and length of balloon

in order to

Minimize dilatation of normal blood vessel