BOVINE ARCH: Definitions and Implications

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DISCLOSURE:
Medtronic: consulting, sales training
Arch Branch Anatomy:
More than 20 possible configurations
**Bovine Arch** refers to a group of anatomical configurations of the aortic arch caused by the aberrant or variant origin of the left common carotid artery.
BOVINE = Misnomer (not present in cattle)
‘Normal’:
70% GP (48-84%)
Common origin LCCA-IA:
13% GP (25% Blacks, 8% Whites)
Origin LCCA from IA:
9% GP (10% Blacks, 5% Whites)
TRUE BOVINE ANATOMY: frequently present in cattle
Z-2 TEVAR = 40% of all TEVAR procedures
Bovine Arch – A Marker for Thoracic Aortic Aneurysm

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Study Aims

• Bovine arch traditionally viewed as “normal,” clinically insignificant variant

• Clinicians have noted in general terms that bovine arch is common in patients with thoracic aortic aneurysm (TAA)

• This study aims to better define association between bovine arch and aortic disease, including TAA development and complications
Patient Population

- Aneurysm Group: 175 patients with known TAA and thoracic CT or MRI scan on record, randomly selected from Yale Center for Thoracic Aortic Disease database

- Control Group: 240 patients without TAA, randomly selected from all patients who underwent thoracic CT scan at Yale-New Haven Hospital between May 2006 and May 2008
## Results: Bovine Arch and TAA

### Table 1. Incidence of Bovine Arch (BA) by TAA Location and Compared to Non-TAA Control Group

<table>
<thead>
<tr>
<th>ANEURYSM GROUP</th>
<th>BA+</th>
<th>BA-</th>
<th>% BA+</th>
<th>P value (vs. comparison)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All TAA (n=174)</td>
<td>36</td>
<td>138</td>
<td>20.7</td>
<td>&lt;0.0001 (vs. No TAA)</td>
</tr>
<tr>
<td>Ascending TAA</td>
<td>17</td>
<td>71</td>
<td>19.3</td>
<td>0.19 (vs. Desc)</td>
</tr>
<tr>
<td>Descending TAA</td>
<td>13</td>
<td>31</td>
<td>29.5</td>
<td>0.20 (vs. Root)</td>
</tr>
<tr>
<td>Arch TAA</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0.80 (vs. Asc)</td>
</tr>
<tr>
<td>Root TAA</td>
<td>6</td>
<td>30</td>
<td>16.7</td>
<td>0.80 (vs. Asc)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTROL GROUP</th>
<th>BA+</th>
<th>BA-</th>
<th>%BA+</th>
<th>P value (vs. comparison)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No TAA (n=240)</td>
<td>16</td>
<td>224</td>
<td>6.7</td>
<td>&lt;0.0001 (vs. All TAA)</td>
</tr>
</tbody>
</table>

Incidence of bovine arch significantly greater in patients with TAA than in patients without TAA

Imaging reports (radiologists) cited bovine arch in only 6 of 36 bovine arch patients
Table 2. TAA Growth Rate in Patients With and Without Bovine Arch (cm/yr) - comparison data from Coady et al.3*

<table>
<thead>
<tr>
<th>Population</th>
<th>All patients*</th>
<th>BA- (n)</th>
<th>BA+ (n)</th>
<th>p value (BA- vs. BA+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall TAA</td>
<td>0.10</td>
<td>0.16 (46)</td>
<td>0.42 (23)</td>
<td>0.014</td>
</tr>
<tr>
<td>Chronic dissection</td>
<td>0.31</td>
<td>0.27 (12)</td>
<td>0.57 (9)</td>
<td>0.046</td>
</tr>
<tr>
<td>No dissection</td>
<td>0.05</td>
<td>0.11 (35)</td>
<td>0.33 (14)</td>
<td>0.14</td>
</tr>
<tr>
<td>Root/Ascending/Arch</td>
<td>0.09</td>
<td>0.11 (27)</td>
<td>0.28 (15)</td>
<td>0.15</td>
</tr>
<tr>
<td>Descending</td>
<td>0.12</td>
<td>0.20 (20)</td>
<td>0.68 (8)</td>
<td>0.026</td>
</tr>
</tbody>
</table>

TAAs grow significantly faster in patients with bovine arch than in patients without bovine arch

Faster expansion rate in setting of bovine arch statistically significant in descending and chronically dissected aneurysms
Table 3. Dissection in TAA, by BA groupings

<table>
<thead>
<tr>
<th></th>
<th>BA+ (n=36)</th>
<th>BA- (n=138)</th>
<th>p value (BA- vs. BA+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>3</td>
<td>19</td>
<td>0.57</td>
</tr>
<tr>
<td>Type B</td>
<td>11</td>
<td>22</td>
<td>0.057</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>41</td>
<td>0.32</td>
</tr>
<tr>
<td>% Dissected</td>
<td>38.9</td>
<td>29.7</td>
<td></td>
</tr>
</tbody>
</table>

Higher overall dissection rate in bovine arch patients, but not statistically significant

Near-significant association between bovine arch and type B dissection rate

Other results:

• No significant association between bovine arch and bicuspid aortic valve
Atypical aortic arch branching variants: A novel marker for thoracic aortic disease

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(CONCLUSIONS)

Our results strongly associate the presence of anomalous aortic arch branching patterns with TAD. Prevalence of aortic arch variations is elevated in patients with TAD when compared with the general population. We conclude that abnormal aortic arch patterns should no longer be considered clinically irrelevant or benign variations; instead, clinicians need to be aware of the presence of aortic branching variations as a potential anatomic marker for future development of TAD.)
Conclusions: Variant aortic arch anatomy is significantly more prevalent in patients with TBAD. Patients with TBAD with variant arch anatomy had a higher percentage of dissection-related aortic repair. Preliminary 4D flow MRI data show differences in hemodynamic flow patterns between variant and conventional arches. Studies of long-term outcomes based on arch anatomy may offer additional insight to TBAD genesis and possibly influence management decisions. (J Vasc Surg 2018;68:1640-8.)
Conclusions

1) Bovine aortic arch is significantly more common in patients with TAA than in the general population.

2) Aortas in bovine arch patients grow faster than general TAAs.

3) Bovine arch patients tend to dissect, especially in the descending aorta.

4) Radiology reports often overlook bovine arch anatomy.
5) These observations argue strongly that bovine arch should not be considered a normal variant of aortic arch anatomy.
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