GANESH ELUMALAI et al CLASSIFICATION OF TYPE - I and TYPE - II “BRANCHING PATTERNS OF THE LEFT ARCH AORTA”

*Ganesh Elumalai¹, Sushma Chodisetty², Pavan Kumar D³

¹Department of Embryology, College of Medicine, Texila American University, South America
²Department of Casualty and Emergency medicine, Tribhuvan University, National Medical College, Nepal
³Senior Resident, Department of General Medicine, Guntur General Hospital, Andhrapradesh, India

Abstract: The adult archetype of the Aortic arch and its branches are formed, due to the different growth pattern of the aortic or branchial arch arteries and their associated “migration” and “merging” of their branches. Knowledge about the branching pattern of the aortic arches was utmost significant during supra-aortic angiography, aortic instrumentation, thoracic, head and neck surgeries. The branching pattern of the arch of the aortas shows significant variations but, until today there was no uniform data available for the classification of these branching patterns. The left arch aortas are most common observation than the right arch of the aorta. The purpose of this study to review the branching patterns of the left arch aorta and describe the uniform classification of branching patterns of the left arch aorta. Subsequent to the complete analysis of various (normal and unusual) types of the branching patterns of the left arch aorta, we designed totally three variables to classify it, the variables are 1. (T)-Trunks, 2. (V)-Variations, and 3. (P)-Patterns. The (T)-Trunks variables are denoted by roman numerals I – VI, the (V)-Variation variables (now concerns only for the Type-I and Type-II) are marked as numerical values from 1-22 and, the (P)-Patterns variables are distinct as (now concerns only for the Type-I and Type-II) alphabets values a – f. In future, if any new patterns were identified under this Type – II, Doubled trunk left aortic arch configuration, it would be followed next to the Variations-22, Type-II (22b). The further classification under the Trunk-III to VI variables, and its Variations and Patterns would be discussed in future.

Keywords: Arch of aorta, Brachiocephalic trunk, Common carotid artery, Subclavian artery, Vertebral artery.

1. Introduction

Arch of the aorta, was the upward continuation of the Ascending aorta and it was normally branched out into three vessels patterns called, the brachiocephalic trunk (BCT) or innominate artery, the left common carotid artery (LCCA) and the left subclavian artery (LSA), incidence in 74.0% - 89.4% cases in radiological investigations [1,2,3] and 63.5% to 77.3% in cadaveric studies [4,5,6]. The adult archetype of the Aortic arch and its branches are formed, due to the different growth pattern of the aortic or branchial arch arteries and their associated “migration” and “merging” of their branches [7]. The most common variance of the aortic arch was observed as the anomalous aortic arch origin of the left vertebral artery (LVA). The anomalous branching patterns in the aortic arch are due to the deviations or disturbances the normal growth pattern of the aortic or branchial arch arteries during the embryonic period. Knowledge about the branching pattern of the aortic arches was utmost significant during supra-aortic angiography, aortic instrumentation, thoracic, head and neck surgeries. The aim of the present study to review the branching patterns of the left arch aorta and describe the uniform classification of branching patterns of the left arch aorta.

The universal classifications of the branching patterns of the arch aorta were noticed as Type-A, Type-B, Type-C…etc or Type-I, Type-II, Type-III… and so on [8 -17]. In this, the Type-I or Type- A patterns of one author did not correspond with the same observations on the other authors. Also, there were no clear uniform pieces of information about, what these A, B, C… or I, II, III… symbols are indicating. The branching pattern of the arch of the aortas shows significant variations but, until today there was no uniform data’s are available for their classifications. The left arch aortas are most common observation than the right arch aorta [18]. The purpose of this study to review the branching patterns of the left arch aorta and describe the uniform classification of branching patterns of the left arch aorta.

2. Materials

The aim of the present study to review the branching patterns of the left arch aorta and describe the uniform classification for the branching patterns of the left arch aorta. The complete literature review surveys were conducted and cumulated all the pieces of information received nearly from the past twenty-five decades of previous workers on the branching
patterns of the arch of the aorta, derived from the different demographical observations [19 - 228].

3. Methods of Classifications:

Subsequent to the complete analysis of various (normal and unusual) types of the branching patterns of the left arch aorta, we designed totally three variables to classify it, the variables are 1. (T)-Trunks, 2. (V)-Variations, and 3. (P)-Patterns. The (T)-Trunks variables are denoted by roman numerals I – VI, the (V)-Variation variables (now concerns only for the Type-I and Type-II) are marked as numerical values from 1-22 and, the (P)-Patterns variables are distinct as (now concerns only for the Type-I and Type-II) alphabets values a – f. (Table - 1).

Table 1: Variables and its Symbols used in “Ganesh Elumalai et al, Classification of “Branching patterns of the Left Arch Aorta”

| Ganesh Elumalai et al, Classification of “Branching patterns of the Left Arch Aorta” |
|---------------------------------|------------------|------------------|------------------|
| Variables                      | (T)-Trunk (s)    | (V)-Variation (s)| (P)-Patterns (s) |
| Symbols                        | I - IV           | (for TYPE I & II) 1 - 22 | (for TYPE I & II) a - f |

4. Classification of “Branching Patterns of The Left Arch Aorta”:

The (T)-Trunks variables are denoted by roman numerals, Type-I to Type-IV. In this, the roman numerals are indicating the total number of trunks arises from the arch (left) of the aorta. The Type - I indicated as Singled (one) trunk branch configuration of the left arch aorta, the Type - II for Doubled (two) trunks, the other trunk variables are Type – III resembles the Tripled (three) trunks, the Type - IV shows Quadriad (four) trunks, the Type - V exhibits Pentad (five) trunks and the Type - VI distinct as Hexad (six) trunk branching configurations arises from the left arch aorta. Under the Type - II (Doubled (two) trunks) to Type - VI (Hexad (six) trunks) Trunks) variables, the (V)-Variations variables were sub-classified as numerical values for the normal and unusual branching configurations from the left arch aorta. In the Type - I and Type – II variables, Variations-1 to Variations-22 subtypes were further sub-classified into different (P)-Pattern variables, indicated as the alphabets values from the Pattern-a, to Pattern-f.

4.1 Type - I (Singled trunk): (Table-2)

The Type - I, Singled trunk branching configuration also called as a “true bovine aortic arch”. In the true bovine arch, a single great vessel arises from the arch of the aorta, called the brachiopheal trunk [229, 230]. It gives derivations for the innominate artery, the left common carotid artery, and the left subclavian artery. Further, the innominate artery was branches into the right common carotid artery and the right subclavian artery (Figure-1). Uncommonly the true bovine trunk or Type - I (Singled trunk) left arch, may also exhibit many unusual sub-types variations (Variations-1 to Variations-22) and sub-type patterns (Pattern-a, to Pattern-f) branching configurations follows the Type-II.

Table 2: Ganesh Elumalai et al, Classification of “Type – I” Branching patterns of the Left Arch Aorta

<p>| Ganesh Elumalai et al, Classification of “Branching patterns of the Left Arch Aorta” |
|---------------------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Single trunk pattern (I)</td>
<td>-</td>
<td>True Bovine trunk (T)</td>
</tr>
</tbody>
</table>

Figure 1: Type - I (Singled trunk) - The “True Bovine trunk” Left Arch Aorta. (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA))

4.2 TYPE - II (Doubled trunk):

The Type - II, Doubled trunk aortic arches shows, the two trunk branching configurations from the arch of the aorta. Under this Type - II, Doubled trunk, the (V) Variation variables were sub-classified into twenty-two numerical values and it is marked from Variations-1 to Variations-22 sub-types of unusual branching configurations from the left arch aorta. The Variations-1 to Variations-22 sub-types variables were further sub-classified into different (P)-Pattern variables and it was indicated as the alphabets values from the Pattern-a to Pattern-f.

The Variations-1, Type - II, Doubled trunk indicates the brachiopheal trunk (RBCT) as the first branch and, accompanied with an unusual trunk.
Both are originated from the left arch aorta, as Variations-1, Type - II, Doubled trunk configuration. In this, the brachiocephalic trunk has remained as the Right brachiocephalic trunk (RBCT) accompanied with an unusual trunk called the Left brachiocephalic trunk (LBCT) (formed by the fusion of the left common carotid artery (LCCA) and the left subclavian artery (LSA)). The Variations-1 was further classified into four (P)-Pattern variables, indicated as Pattern-a, to Pattern-d (Table-3). This Variations-1, Type - II, Doubled trunk type branching configurations are marked as Type-II(1a), Type-II(1b), Type-II(1c) and Type-II(1d), (Figure-2).

Table 3: Ganesh Elumalai et al, Classification of “Variations-1, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
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<tbody>
<tr>
<td>2</td>
<td>Doubled Trunk (II)</td>
<td>1a</td>
<td>RBCT + LBCT</td>
</tr>
<tr>
<td>3</td>
<td>Doubled Trunk (II)</td>
<td>1b</td>
<td>RBCT + Reverse LBCT</td>
</tr>
<tr>
<td>4</td>
<td>Doubled Trunk (II)</td>
<td>1c</td>
<td>Reverse RBCT + LBCT</td>
</tr>
<tr>
<td>5</td>
<td>Doubled Trunk (II)</td>
<td>1d</td>
<td>Reverse RBCT + Reverse LBCT</td>
</tr>
</tbody>
</table>

Figure 2: Variations-1, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(1a), Type-II(1b), Type-II(1c), and Type-II(1d). (Right common carotid (RCCA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-2, Type - II, Doubled trunk displays, the brachiocephalic trunk (RBCT) as a first branch and accompanied with an unusual trunk called Vertebral-LBCT, both are originated from the left arch aorta, as Variations-2, Type - II, Doubled trunk configuration. In this, the brachiocephalic trunk has remained as Right brachiocephalic trunk (RBCT) accompanied with an unusual trunk called the “Vertebral-LBCT” trunk (formed by the fusion of the left vertebral artery (LVA) with the Left brachiocephalic trunk (LBCT)). The Variations-2 was sub-classified into four (P)-Pattern variables, specified as Pattern-a, to Pattern-d (Table-4). This Variations-2, Type - II, Doubled trunk type branching configurations are noticeable as Type-II(2a), Type-II(2b), Type-II(2c) and Type-II(2d), (Figure-3).

Table 4: Ganesh Elumalai et al, Classification of “Variations-2, Type –I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Doubled Trunk (II)</td>
<td>2a</td>
<td>RBCT + Vertebral LBCT</td>
</tr>
<tr>
<td>7</td>
<td>Doubled Trunk (II)</td>
<td>2b</td>
<td>RBCT + Reverse Vertebral LBCT</td>
</tr>
<tr>
<td>8</td>
<td>Doubled Trunk (II)</td>
<td>2c</td>
<td>Reverse RBCT + Vertebral LBCT</td>
</tr>
<tr>
<td>9</td>
<td>Doubled Trunk (II)</td>
<td>2d</td>
<td>Reverse RBCT + Reverse Vertebral LBCT</td>
</tr>
</tbody>
</table>

Figure 3: Variations-2, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(2a), Type-II(2b), Type-II(2c), and Type-II(2d). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-3, Type - II, Doubled trunk presents with an unusual trunk as the first branch and accompanied with the brachiocephalic trunk (RBCT), both are originated from the left arch aorta, as Variations-3, Type - II, Doubled configurations. In this, the unusual trunk called the Left brachiocephalic trunk (LBCT) was formed by the fusion of the left common carotid artery (LCCA) and the left subclavian artery (LSA). The Variations-3, were sub-classified into four (P)-Pattern variables as Pattern-a, to Pattern-d (Table-5). This Variations-3 Type - II, Doubled trunk type, branching
configurations were obvious into Type-II(3a), Type-II(3b), Type-II(3c) and Type-II(3d), (Figure-4).

Table 5: Ganesh Elumalai et al, Classification of "Variations-3, Type – I I Doubled Trunk" Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Doubled Trunk (II)</td>
<td>3a</td>
<td>LBCT + RBCT</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>3b</td>
<td>LBCT + Reverse RBCT</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>3c</td>
<td>Reverse LBCT + RBCT</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>3d</td>
<td>Reverse LBCT + Reverse RBCT</td>
</tr>
</tbody>
</table>

Figure 4: Variations-3, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(3a), Type-II(3b), Type-II(3c), and Type-II(3d). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-4, Type - II, Doubled trunk shows, the left brachiocephalic trunk (LBCT) as a first branch and it was accompanied with an unusual trunk called Vertebral-RBCT, both are originated from the arch of the aorta, as Variations-4 Type - II, Doubled trunk configuration.

In this, the unusual trunk called the Vertebral-RBCT was formed by the fusion of the left vertebral artery (LVA) with the Right brachiocephalic trunk (RBCT).

The Variations-4 were further classified into four (P)-Pattern variables, mentioned as Pattern-a, to Pattern-d (Table-6). This Variations-4, Type - II, Doubled trunk type, branching configurations are apparent into Type-II(4a), Type-II(4b), Type-II(4c) and Type-II(4d), (Figure-5).

Table 6: Ganesh Elumalai et al, Classification of "Variations-4, Type – I I Doubled Trunk" Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Doubled Trunk (II)</td>
<td>4a</td>
<td>LBCT + Vertebral RBCT</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>4b</td>
<td>LBCT + Reverse Vertebral RBCT</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>4c</td>
<td>Reverse LBCT + Vertebral RBCT</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>4d</td>
<td>Reverse LBCT + Reverse Vertebral RBCT</td>
</tr>
</tbody>
</table>

Figure 5: Variations-4, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(4a), Type-II(4b), Type-II(4c), and Type-II(4d). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-5, Type - II, Doubled trunk exhibits with, the “Truncus Bicaroticus” as a first trunk accompanied with another unusual trunk originated from the left arch aorta, as Variations-5 Type - II, Doubled trunk.

The left common carotid artery (LCCA) origin was migrated to the right and merges with the originated trunk of the brachiocephalic trunk (BCT) or innominate artery to form a single common trunk called the “Truncus Bicaroticus”.

The unusual trunk presents as either the left subclavian artery (LSA) or the fusion of the left subclavian artery (LSA) with the left vertebral artery (LVA) to forms the “Common vertebral-subclavian trunk (CVST)” or “Common subclavian-vertebral trunk (CSVT)”.

The Variations-5 were sub-classified into three (P)-Pattern variables as the Pattern-a, to Pattern-c (Table-7). This Variations-5 Type - II, Doubled trunk, branching configurations are evident
as Type-II(5a), Type-II(5b) and Type-II(5c), (Figure-6).

Table 7: Ganesh Elumalai et al, Classification of “Variations-5, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTEREN</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Doubled Trunk (II)</td>
<td>5a</td>
<td>Truncus Bicaroticus + LSA</td>
</tr>
<tr>
<td>19</td>
<td>Doubled Trunk (II)</td>
<td>5b</td>
<td>Truncus Bicaroticus + CVST</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>5c</td>
<td>Truncus Bicaroticus + CSVT</td>
</tr>
</tbody>
</table>

This Variations-6, Type - II, Doubled trunk, branching configurations are marked as Type-II(6a), Type-II(6b) and Type-II(6c), (Figure-7).

Table 8: Ganesh Elumalai et al, Classification of “Variations-6, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTEREN</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Doubled Trunk (II)</td>
<td>6a</td>
<td>LSA + Truncus Bicaroticus</td>
</tr>
<tr>
<td>22</td>
<td>Doubled Trunk (II)</td>
<td>6b</td>
<td>CVST + Truncus Bicaroticus</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>6c</td>
<td>CSVT + Truncus Bicaroticus</td>
</tr>
</tbody>
</table>

Figure 6: Variations-5, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(5a), Type-II(5b) and Type-II(5c). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

Figure 7: Variations-6, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(6a), Type-II(6b) and Type-II(6c). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-6, Type - II, Doubled trunk displays, the unusual trunk presents as either the left subclavian artery (LSA) or the fusion of left subclavian artery (LSA) with the left vertebral artery (LVA) to forms the Common vertebro-subclavian trunk (CVST) or Common subclavian- vertebral trunk (CSVT) as the first trunk accompanied with an unusual trunk called the “Truncus Bicaroticus”, both are originated from the left arch aorta, as Variations-6, Type - II, Doubled trunk.

The left common carotid artery (LCCA) origin was migrated to the right and merges with the originated trunk of the brachiocephalic trunk (BCT) or innominate artery to form a single common trunk called the “Truncus Bicaroticus”.

The Variations-6 were further classified into three (P)-Pattern variables as the Pattern-a, to Pattern-c (Table-8).

The Variations-7, Type - II, Doubled trunk demarcates, the “Reverse Truncus Bicaroticus” as the first trunk accompanied with the unusual trunk presents as either the left subclavian artery (LSA) or the fusion of left subclavian artery (LSA) with the left vertebral artery (LVA) to forms the Common vertebro-subclavian trunk (CVST) or Common subclavian- vertebral trunk (CSVT), both are originated from the left arch aorta, as Variations-7, Type - II, Doubled trunk.

The left common carotid artery (LCCA) origin was migrated beyond to the right and merges with the originated trunk of the brachiocephalic trunk (BCT) or innominate artery to form a single common trunk called the “Reverse Truncus Bicaroticus”.

The Variations-7 were sub-classified into three (P)-Pattern variables as the Pattern-a, to Pattern-c (Table-9). This Variations-7 Type - II,
Doubled trunk, branching configurations are manifest as Type-II(7a), Type-II(7b) and Type-II(7c), (Figure-8).

Table 9: Ganesh Elumalai et al, Classification of “Variations-7, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Doubled Trunk (II)</td>
<td>7a</td>
<td>ReverseTruncus Bicaroticus + LSA</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>7b</td>
<td>ReverseTruncus Bicaroticus + CVST</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td>7c</td>
<td>ReverseTruncus Bicaroticus + CSVT</td>
</tr>
</tbody>
</table>

Figure 8: Variations-7, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(7a), Type-II(7b) and Type-II(7c). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-8 were sub-classified into three (P)-Pattern variables as the Pattern-a, to Pattern-c (Table-10). This Variations-8 Type - II, Doubled trunk, branching configurations are evident as Type-II(8a), Type-II(8b) and Type-II(8c), (Figure-9).

Table 10: Ganesh Elumalai et al, Classification of “Variations-8, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
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<th>BRANCHING PATTERN</th>
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<tbody>
<tr>
<td>27</td>
<td>Doubled Trunk (II)</td>
<td>8a</td>
<td>Stem BCT + LSA</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td>8b</td>
<td>Stem BCT + CVST</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>8c</td>
<td>Stem BCT + CSVT</td>
</tr>
</tbody>
</table>

Figure 9: Variations-8, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(8a), Type-II(8b) and Type-II(8c). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-9, Type - II, Doubled trunk presents with, the unusual trunk presents as either the left subclavian artery (LSA) or the fusion of the left subclavian artery (LSA) with the left vertebral artery (LVA) to forms the “Common vertebro-subclavian trunk (CVST)” or “Common subclavian-vertebral trunk (CSVT)” as the first trunk accompanied with Stem BCT, as the another unusual trunk, both are originated from the left arch aorta, as Variations-9, Type - II, Doubled trunk.

The left common carotid artery (LCCA) arises from the brachiocephalic trunk (BCT) or innominate artery at an average distance of one centimeter (1cm) to two and a half centimeters (2.5cms) from the Aortic arch, but not sharing the true common origin and formed one common trunk configuration, called as the “Stem BCT”.

The unusual trunk presents as either the left subclavian artery (LSA) or the fusion of the left subclavian artery (LSA) with the left vertebral artery (LVA) to forms the “Common vertebro-subclavian trunk (CVST)” or “Common subclavian-vertebral trunk (CSVT)” as the first trunk accompanied with Stem BCT, as the another unusual trunk, both are originated from the left arch aorta, as Variations-9, Type - II, Doubled trunk.

The left common carotid artery (LCCA) arises from the brachiocephalic trunk (BCT) or innominate artery at an average distance of one centimeter (1cm) to two and a half centimeters (2.5cms) from the Aortic arch, but not sharing the true common origin and formed one common trunk configuration, called as the “Stem BCT.”
The Variations-9 were sub-classified into three (P)-Pattern variables as the Pattern-a, to Pattern-c (Table-11). This Variations-9 Type - II, Doubled trunk, branching configurations are obvious as Type-II(9a), Type-II(9b) and Type-II(9c), (Figure-10).

### Table 11: Ganesh Elumalai et al, Classification of "Branching patterns of the Left Arch Aorta"

<table>
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<th>BRANCHING PATTEREN</th>
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<tbody>
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<td>LSA + Stem BCT</td>
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<tr>
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<td>Doubled Trunk (II)</td>
<td>9b</td>
<td>CVST + Stem BCT</td>
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<td>32</td>
<td>Doubled Trunk (II)</td>
<td>9c</td>
<td>CSVT + Stem BCT</td>
</tr>
</tbody>
</table>

**Figure 10:** Variations-9, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(9a), Type-II(9b) and Type-II(9c). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-10, Type - II, Doubled trunk reveals, the "Reverse Stem BCT" as the first trunk accompanied with the unusual trunk presents as either the left subclavian artery (LSA) or the fusion of the left subclavian artery (LSA) with the left vertebral artery (LVA) to forms the “Common vertebro-subclavian trunk (CVST)” or “Common subclavian-vertebral trunk (CSVT)”, both are originated from the left arch aorta, as Variations-10, Type - II, Doubled trunk.

The Variations-10 were sub-classified into three (P)-Pattern variables as the Pattern-a, to Pattern-c (Table-12). This Variations-10 Type - II, Doubled trunk, branching configurations are observable as Type-II(10a), Type-II(10b) and Type-II(10c), (Figure-11).

**Table 12: Ganesh Elumalai et al, Classification of “Variations-10, Type – II I Doubled Trunk” Branching patterns of the Left Arch Aorta**

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTEREN</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Doubled Trunk (II)</td>
<td>10a</td>
<td>Reverse Stem BCT + LSA</td>
</tr>
<tr>
<td>34</td>
<td>Doubled Trunk (II)</td>
<td>10b</td>
<td>Reverse Stem BCT + CVST</td>
</tr>
<tr>
<td>35</td>
<td>Doubled Trunk (II)</td>
<td>10c</td>
<td>Reverse Stem BCT + CSVT</td>
</tr>
</tbody>
</table>

**Figure 11:** Variations-10, Type - II (Doubled trunk) Left Arch Aorta: shows the variants of Type-II(10a), Type-II(10b) and Type-II(10c). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); RBCT-Right Brachiocephalic Trunk and LBCT-Left Brachiocephalic Trunk)

The Variations-11, Type - II, Doubled trunk represents, the Common Carotid trunk (CCT) formed by the fusion of right and left common carotid arteries, as a first branch, accompanied with an unusual common trunk called the Common Subclavian trunk (CST).

The Common Subclavian trunk (CST), was formed by the fusion of right and left subclavian arteries as the second trunk, both are originated from the left arch aorta, as Variations-11 Type - II, Doubled trunk configuration.

The Variations-11 was sub-classified into four (P)-Pattern variables, indicated as Pattern-a, to Pattern-d (Table-13).

The Variations-11, Type - II, Doubled trunk branching configurations are visible as Type-II(11a), Type-II(11b), Type-II(11c) and Type-II(11d), (Figure-12).
Table 13: Ganesh Elumalai et al, Classification of “Variations-II, Type –II Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>Doubled Trunk (II)</td>
<td>11a</td>
<td>CCT + CST</td>
</tr>
<tr>
<td>37</td>
<td>Doubled Trunk (II)</td>
<td>11b</td>
<td>CCT + Reversed CST</td>
</tr>
<tr>
<td>38</td>
<td>Doubled Trunk (II)</td>
<td>11c</td>
<td>Reversed CCT + CST</td>
</tr>
<tr>
<td>39</td>
<td>Doubled Trunk (II)</td>
<td>11d</td>
<td>Reversed CCT + Reversed CST</td>
</tr>
</tbody>
</table>

Figure 12: Variations-11, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(11a), Type-II(11b), Type-II(11c) and Type-II(11d). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); CCT-Common Carotid Trunk and CST-Common Subclavian Trunk)

The Variations-12, Type - II, Doubled trunk characterized as, the Common Subclavian trunk (CST), formed by the fusion of right and left subclavian arteries, as the first branch accompanied with another unusual common trunk called the Common Carotid trunk (CCT).

The Common Carotid trunk (CCT) was formed by the fusion of right and left common carotid arteries, it presents as the second trunk, both are originated from the left arch aorta, as Variations-12, Type - II, Doubled trunk configuration.

The Variations-12 were further classified into four (P)-Pattern variables, indicated as Pattern-a, to Pattern-d (Table-14). The Variations-12, Type - II, Doubled trunk branching configurations are in evidence as Type-II(12a), Type-II(12b), Type-II(12c) and Type-II(12d), (Figure-13).

Table 14: Ganesh Elumalai et al, Classification of “Variations-12, Type –II Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>Doubled Trunk (II)</td>
<td>12a</td>
<td>CCT + CST</td>
</tr>
<tr>
<td>41</td>
<td>Doubled Trunk (II)</td>
<td>12b</td>
<td>CST + Reversed CCT</td>
</tr>
<tr>
<td>42</td>
<td>Doubled Trunk (II)</td>
<td>12c</td>
<td>Reversed CST + CCT</td>
</tr>
<tr>
<td>43</td>
<td>Doubled Trunk (II)</td>
<td>12d</td>
<td>Reversed CST + Reversed CCT</td>
</tr>
</tbody>
</table>

Figure 13: Variations-12, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(12a), Type-II(12b), Type-II(12c) and Type-II(12d). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); CCT-Common Carotid Trunk and CST-Common Subclavian Trunk)

The Variations-13 to 22, stands for the unusual Type - II, Doubled trunk left aortic arch configurations. In these Variations, one or two more frequent aortic arch branches are arises from the sources other than the (left) arch of the aorta.

The Variations-13, Type - II, Doubled trunk portrays, the presence of Right brachiocephalic trunk (RBCT) trunk as the first branch accompanied with other unusual second trunk, both are originated from the left arch aorta, as Variations-13, Type - II, Doubled trunk configuration.

The Variations-13, was sub-classified into four (P)-Pattern variables, indicated as Pattern-a, to Pattern-d (Table-15). The Variations-13, Type - II, Doubled trunk branching configurations are able to seen as Type-II(13a), Type-II(13b), Type-II(13c) and Type-II(13d), (Figure-14).
Table 15: Ganesh Elumalai et al, Classification of “Variations-13, Type –I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>Doubled Trunk (II)</td>
<td>13a</td>
<td>RBCT + LCCA (LSA arises from the DTA)</td>
</tr>
<tr>
<td>45</td>
<td>Doubled Trunk (II)</td>
<td>13b</td>
<td>RBCT + LSA (LCCA arises from the DTA)</td>
</tr>
<tr>
<td>46</td>
<td>Doubled Trunk (II)</td>
<td>13c</td>
<td>RBCT + CVST (LCCA arises from the DTA)</td>
</tr>
<tr>
<td>47</td>
<td>Doubled Trunk (II)</td>
<td>13d</td>
<td>RBCT + CSVT (LCCA arises from the DTA)</td>
</tr>
</tbody>
</table>

The Variations-14, Type - II, Doubled trunk depicts, the presence of Right subclavian artery (RSA) as a first trunk with other unusual second trunk, both are originated from the left arch aorta, as Variations-14, Type - II, Doubled trunk configuration.

The Variations-14, was sub-classified into six (P)-Pattern variables, indicated as Pattern-a, to Pattern-f (Table-16).

The Variations-14, Type - II, Doubled trunk branching configurations are discoverable as Type-II(14a), Type-II(14b), Type-II(14c), Type-II(14d), Type-II(14e) and Type-II(14f) (Figure-15).

Table 16: Ganesh Elumalai et al, Classification of “Variations-14, Type – II Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>Doubled Trunk (II)</td>
<td>14a</td>
<td>RSA + RCCA (LCCA and LSA are arises from the DTA)</td>
</tr>
<tr>
<td>49</td>
<td>Doubled Trunk (II)</td>
<td>14b</td>
<td>RSA + LCCA (RCCA arises from Ascending aorta or DTA and LSA are arises from the DTA)</td>
</tr>
<tr>
<td>50</td>
<td>Doubled Trunk (II)</td>
<td>14c</td>
<td>RSA + LBCT (RCCA arises from Ascending aorta or DTA)</td>
</tr>
<tr>
<td>51</td>
<td>Doubled Trunk (II)</td>
<td>14d</td>
<td>RSA + LSA (RCCA and LCCA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>52</td>
<td>Doubled Trunk (II)</td>
<td>14e</td>
<td>RSA + CCT (LSA arises from the DTA)</td>
</tr>
<tr>
<td>53</td>
<td>Doubled Trunk (II)</td>
<td>14f</td>
<td>RSA + Reverse CCT (LSA arises from the DTA)</td>
</tr>
</tbody>
</table>
Variations-15, Type - II, Doubled trunk configuration.

The Variations-15, was sub-classified into four (P)-Pattern variables, indicated as Pattern-a, to Pattern-d (Tale-17).

The Variations-15, Type - II, Doubled trunk branching configurations are perceivable as Type-II(15a), Type-II(15b), Type-II(15c) and Type-II(15d), (Figure-16).

Table 17: Ganesh Elumalai et al, Classification of “Variations-15, Type –I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td></td>
<td>15a</td>
<td>RSA + Vertebral-LBCT (RCCA arises from Ascending aorta or DTA)</td>
</tr>
<tr>
<td>55</td>
<td>Doubled Trunk (II)</td>
<td>15b</td>
<td>RSA + Reversed Vertebral-LBCT (RCCA arises from Ascending aorta or DTA)</td>
</tr>
<tr>
<td>56</td>
<td></td>
<td>15c</td>
<td>RSA + CVST (RCCA arises from Ascending aorta or DTA and LSA are arises from the DTA)</td>
</tr>
<tr>
<td>57</td>
<td></td>
<td>15d</td>
<td>RSA + CVST (RCCA arises from Ascending aorta or DTA and LSA are arises from the DTA)</td>
</tr>
</tbody>
</table>

Figure 16: Variations-15, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(15a), Type-II(15b), Type-II(15c),and Type-II(15d), (Left Brachiocephalic Trunk (LBCT); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); CVST-Common Vertebro-Subclavian Trunk and CSVT-Common Subclavian-Vertebral Trunk)

The Variations-16, Type - II, Doubled trunk describes, the presence of Right common carotid artery (RCCA) alone or in the form of Common Carotid Trunk (CCT) as a first trunk, accompanied with another unusual second trunk, and both are originated from the left arch aorta, as Variations-16, Type - II, Doubled trunk configuration. The Variations-16, was sub-classified into five (P)-Pattern variables, indicated as Pattern-a, to Pattern-e (Tale-18). The Variations-16, Type - II, Doubled trunk branching configurations are identified as Type-II(16a), Type-II(16b), Type-II(16c), Type-II(16d) and Type-II(16e), (Figure-17).

Table 18: Ganesh Elumalai et al, Classification of “Variations-16, Type –I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>58</td>
<td></td>
<td>16a</td>
<td>RCCA + LBCT (RCCA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>59</td>
<td>Doubled Trunk (II)</td>
<td>16b</td>
<td>RCCA + LCCA (RCCA and LSA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>16c</td>
<td>RCCA + LSA (RCCA and LCCA are arises from Ascending aorta or DTA)</td>
</tr>
<tr>
<td>61</td>
<td></td>
<td>16d</td>
<td>CCT + LSA (LCCA arises from the DTA)</td>
</tr>
<tr>
<td>62</td>
<td></td>
<td>16e</td>
<td>RCCA + RSA (LCCA and LSA are arises from the DTA)</td>
</tr>
</tbody>
</table>

Figure 17: Variations-16, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(16a), Type-II(16b), Type-II(16c), Type-II(16d) and Type-II(16e). (Right common carotid (RCCA); Right subclavian artery (LSA); CVST-Common Vertebro-Subclavian Trunk and CSVT-Common Subclavian-Vertebral Trunk)
The Variations-17, Type - II, Doubled trunk illustrates, the presence of Right common carotid artery (RCCA) as a first trunk with other unusual second trunk in the combination of Left Vertebral artery (LSA), both are originated from the left arch aorta, as Variations-17, Type - II, Doubled trunk configuration. The Variations-17, was further classified into four (P)-Pattern variables, indicated as Pattern-a, to Pattern-d (Table-19). The Variations-17, Type - II, Doubled trunk branching configurations are recognized as Type-II(17a), Type-II(17b), Type-II(17c) and Type-II(17d), (Figure-18).

Table 19: Ganesh Elumalai et al, Classification of “Variations-17, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>Doubled Trunk (II)</td>
<td>17a</td>
<td>RCCA + Vertebral-LBTC (RSA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>64</td>
<td>Doubled Trunk (II)</td>
<td>17b</td>
<td>RCCA + Reversed Vertebral-LBTC (LSA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>65</td>
<td>Doubled Trunk (II)</td>
<td>17c</td>
<td>RCCA + CVST (LCCA arises from the Ascending aorta and the RSA originated form DTA)</td>
</tr>
<tr>
<td>66</td>
<td>Doubled Trunk (II)</td>
<td>17d</td>
<td>RCCA + CSVT (LCCA arises from the Ascending aorta and the RSA originated form DTA)</td>
</tr>
</tbody>
</table>

The Variations-18, Type - II, Doubled trunk given a picture, the Common Carotid Trunk (CCT) as a first trunk with an unusual second trunk may present with the combination of the Left Vertebral artery (LSA), both are originated from the left arch aorta, as Variations-18, Type - II, Doubled trunk configuration. The Variations-18, was sub-classified into four (P)-Pattern variables, indicated as Pattern-a, to Pattern-d (Table-20). This Variations-18, Type - II, Doubled trunk branching configurations are noticed as Type-II(18a), Type-II(18b), Type-II(18c) and Type-II(18d), (Figure-19).

Table 20: Ganesh Elumalai et al, Classification of “Variations-18, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>67</td>
<td>Doubled Trunk (II)</td>
<td>18a</td>
<td>CCT + LSA (RSA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>68</td>
<td>Doubled Trunk (II)</td>
<td>18b</td>
<td>CCT + RSA (LSA arises from the DTA)</td>
</tr>
<tr>
<td>69</td>
<td>Doubled Trunk (II)</td>
<td>18c</td>
<td>CCT + CVST (RSA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>70</td>
<td>Doubled Trunk (II)</td>
<td>18d</td>
<td>CCT + CSVT (RSA arises from the Ascending aorta or DTA)</td>
</tr>
</tbody>
</table>
Figure 19: Variations-18, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(18a), Type-II(18b), Type-II(18c), and Type-II(18d). (Common carotid Trunk (CCT); Right Common Carotid artery (RCCA); Left common carotid (LCCA); Right subclavian artery (RSA); Left subclavian artery (LSA); CVST-Common Vertebral-Subclavian Trunk and CVST-Common Subclavian-Vertebral Trunk)

The Variations-19, Type - II, Doubled trunk depicts, the presence of Left brachiocephalic trunk (LBCT) trunk as a first trunk with an unusual second trunk, both are originated from the left arch aorta, as Variations-19, Type - II, Doubled trunk configuration. The Variations-19, were sub-divided into two (P)-Pattern variables, indicated as Pattern-a, and Pattern-b (Tale-21). This Variations-19, Type - II, Doubled trunk branching configurations are sub-classified as Type-II(19a) and Type-II(19b), (Figure-20).

Table 21: Ganesh Elumalai et al, Classification of “Variations-19, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Doubled Trunk (II)</td>
<td>19a</td>
<td>LBCT + RCCA (RSA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>72</td>
<td>Doubled Trunk (II)</td>
<td>19b</td>
<td>LBCT + RSA (RCCA arises from the Ascending aorta or DTA)</td>
</tr>
</tbody>
</table>

Figure 20: Variations-19, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(19a) and Type-II(19b). (Left Brachiocephalic Trunk (LBCT); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); Right common carotid (RCCA))

The Variations-20, Type - II, Doubled trunk describes, the presence of Left common carotid artery (LCCA) as a first trunk with another unusual second trunk in the combination of Left Vertebral artery (LSA), both are originated from the left arch aorta, as Variations-20, Type - II, Doubled trunk configuration. The Variations-20, was sub-classified into six (P)-Pattern variables, indicated as Pattern-a, to Pattern-f (Tale-22). This Variations-20, Type - II, Doubled trunk branching configurations are sub-classified as Type-II(20a), Type-II(20b), Type-II(20c), Type-II(20d), Type-II(20e) and Type-II(20f), (Figure-21).

Table 22: Ganesh Elumalai et al, Classification of “Variations-20, Type – I I Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>73</td>
<td>20a</td>
<td>LCCA + LSA (RSA and RCCA arises from the Ascending aorta or DTA)</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>20b</td>
<td>LCCA + RSA (RCCA arises from the Ascending aorta and LSA arises from the DTA)</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>20c</td>
<td>LCCA + RCCA (RSA and LSA arises from the Ascending aorta or DTA)</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>20d</td>
<td>LCCA + RBCT (LSA arises from the DTA)</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>20e</td>
<td>LCCA + CVST (RCCA and RSA arises from the Ascending aorta or DTA)</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>20f</td>
<td>LCCA + CVST (RCCA and RSA arises from the Ascending aorta or DTA)</td>
<td></td>
</tr>
</tbody>
</table>
Type-II(20f). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); Right Brachiocephalic Trunk (RBCT); CVST-Common Vertebro-Subclavian Trunk and CSVT-Common Subclavian-Vertebral Trunk)

The Variations-21, Type - II, Doubled trunk shows, the presence of Left subclavian artery (LSA) as a first trunk with another unusual second trunk, both are originated from the left arch aorta, as Variations-21. Type - II, Doubled trunk configuration. The Variations-21, were further classified into five (P) Pattern variables, indicated as Pattern-a, to Pattern-e (Table-22). This Variations-21, Type - II, Doubled trunk branching configurations are marked as Type-II(21a), Type-II(21b), Type-II(21c) and Type-II(21d), (Figure-22).

Table 22: Ganesh Elumalai et al, Classification of “Variations-21, Type – II Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td></td>
<td>21a</td>
<td>LSA + RSA (RCCA and LCCA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td>21b</td>
<td>LSA + RCCA (RSA and LCCA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>81</td>
<td></td>
<td>21c</td>
<td>LSA + LCCA (RSA and RCCA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>82</td>
<td>Doubled Trunk (II)</td>
<td>21d</td>
<td>LSA + CCT (RSA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>83</td>
<td></td>
<td>21e</td>
<td>LSA + Reverse CCT (RSA arises from the Ascending aorta or DTA)</td>
</tr>
</tbody>
</table>

The Variations-22, Type - II, Doubled trunk describes, the presence of Common subclavian trunk (CST) trunk as a first trunk with other unusual second trunk, both are originated from the left arch aorta, as Variations-22, Type - II, Doubled trunk configuration. The Variations-22, was sub-classified into two (P)-Pattern variables, indicated as Pattern-a, to Pattern-b (Table-24). This Variations-22, Type - II, Doubled trunk branching configurations are evidenced as Type-II(22a) and Type-II(22b), (Figure-23).

Table 24: Ganesh Elumalai et.al, Classification of “Variations-22, Type – II Doubled Trunk” Branching patterns of the Left Arch Aorta

<table>
<thead>
<tr>
<th>S.No</th>
<th>PATTERN</th>
<th>TYPE</th>
<th>BRANCHING PATTERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>84</td>
<td>Doubled Trunk (II)</td>
<td>22a</td>
<td>CST + RCCA (LCCA arises from the Ascending aorta or DTA)</td>
</tr>
<tr>
<td>85</td>
<td></td>
<td>22b</td>
<td>CST + LCCA (RCCA arises from the Ascending aorta or DTA)</td>
</tr>
</tbody>
</table>

Figure 22: Variations-21, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(21a), Type-II(21b), Type-II(21c), and Type-II(21e). (Right common carotid (RCCA); Right subclavian artery (RSA); Left common carotid (LCCA); Left subclavian artery (LSA); Right Brachiocephalic Trunk (RBCT); CCT-Common Carotid Trunk)

Figure 23: Variations-22, Type - II (Doubled trunk) Left Arch Aorta: a shows the variants of Type-II(22a) and Type-II(22b). (Common Subclavian Trunk (CST); Right subclavian artery (RSA); Left subclavian artery (LSA); Right common carotid (RCCA); Left common carotid (LCCA))

5. Discussion:

Arch of the aorta, is the upward continuation of the Ascending aorta and it is normally branching into three vessels patterns called, the brachiocephalic trunk (BCT) or innominate artery, the left common carotid artery (LCCA) and the left subclavian artery (LSA), incidence in 74.0%
- 89.4% cases in radiological investigations [1,2,3] and 63.5% to 77.3% in cadaveric studies [4,5,6]. The adult archtype of the Aortic arch and its branches are formed, due to the different growth pattern of the aortic or branchial arch arteries and their associated “migration” and “merging” of their branches [7]. The most common variance of the aortic arch was observed as the anomalous aortic arch origin of the left vertebral artery (LVA). The anomalous branching patterns in the aortic arch are due to the deviations or disturbances the normal growth pattern of the aortic or branchial arch arteries during the embryonic period. Knowledge about the branching pattern of the aortic arches was utmost significant during supra-aortic angiography, aortic instrumentation, thoracic, head and neck surgeries. The aim of the present study to review the branching patterns of the left arch aorta and describe the uniform classification of branching patterns of the left arch aorta.

If we observed the past five years of the previous works on classification of branching pattern of arch of aorta with the previous references. The majority of the previous workers Ogeng’o, JA et al, and Ajit Kumar et al, [231, 232], are classified the BCT, LCCA and LSA configuration as Type-I pattern. Which is controversy to the Adachi et. al., and Durai Pandian K et al classifications, they classified this BCT, LCCA and LSA pattern as Type-A [233, 234].

According to the Ogeng’o, JA et al and Ajit Kumar et al, Type-I, left arch aorta shows the pattern of Right brachiocephalic trunk, Left common carotid and Left subclavian artery [231, 232], which was the controversy to the Rekha, P et al. Type I pattern, their Type-I pattern shows, the left vertebral artery (LVA) as a branch of the aortic arch between the origins of left common carotid artery and left subclavian artery [235].

The Ogeng’o, JA et al, and Rekha, P et al, describes the TYPE-II as CT (BCT & LCC) and LSA[235]. But, the Ajit Kumar et al, observed the Type-II pattern with an aberrant origin of the left vertebral artery (LVA), which showed a typical vessel arrangement (the BCT, LCCA, LSCA) with the LVA origin between the LCCA and LSA. The left vertebral artery was also arising from the arch of the aorta in addition to the other normal branches [232]. Recently, Vucurevic G et al, observed the aortic arch branching pattern over the 1265 specimens, they describe the Type-II patterns as a double brachiocephalic trunk pattern [8].

The universal classification the branching patterns of the arch aorta were noticed as Type-A, Type-B, Type-C...etc or Type-I, Type-II, Type-III,... and so on [8 -17]. In this, the Type-I or Type-patterns of one author did not correspond with the various other authors observations of the same Type-I or Type-A patterns. There were no clear uniform pieces of information about, what this A, B, C…, or I, II, III,… symbols are indicating.

The branching patterns of the arch of the aortas are shows significant variations but, until today there was no uniform data are available for the classification of these branching patterns. The left arch aortas are most common observation then the right arch of the aorta [18]. The purpose of this study to review the branching patterns of the left arch aorta and describe the uniform classification of branching patterns of the left arch aorta.

The aim of the present study to review the branching patterns of the left arch aorta and describe the uniform classification for the branching patterns of the left arch aorta. The complete literature review surveys were conducted with the pieces of information received nearly from the past twenty-five decades of previous workers on the branching patterns of the arch of the aorta, derived from the different demographical observations [19 - 228].

6. Conclusion:

Subsequent to the complete analysis of various (normal and unusual) types of the branching patterns of the left arch aorta, we designed totally three variables to classify it, the variables are 1. (T)-Trunks, 2. (V)-Variations, and 3. (P)-Patterns. The (T)-Trunks variables are denoted by roman numerals I–VI, the (V)-Variation variables (only for the Type-I and Type-II) are marked as numerical values from 1-22 and, the (P)-Patterns variables are distinct as alphabets values a–f (Table -1).

The (T)-Trunks variables are denoted by roman numerals, Type-I to Type-IV. In this (T)-Trunk variables, the roman numerals indicate the total number of trunks arises from the arch (left) of the aorta. The Type - I indicate the Singled (one) trunk branch configuration of the left arch aorta, the other trunk variables are Type - II for Doubled (two) trunks, the Type – III resembles the Tripled (three) trunks, the Type - IV shows Quadriadi (four) trunks, the Type - V exhibits Pentad (five) trunks and the Type - VI distinct as Hexad (six) trunks configuration arises from the left arch aorta. Under the Type - II (Doubled (two) trunks) to Type - VI (Hexad (six) trunks) Trunks variables, the (V)-Variations variables (only for the Type-I and Type-II) were sub-classified as numerical values and marked from Variations-1 to Variations-22 types of unusual branching configurations from the left arch aorta. The variables, Variations-1 to Variations-22 subtypes were further sub-classified into different (P)-Pattern variables and it was indicated as the alphabets values as Pattern-a, to Pattern-f. In future, if any new patterns were identified under this Type – II, Doubled trunk left aortic arch configuration, it would be followed next to the Variations-22, Type-II
(22b). The further classification under the Trunk-II to VI and its Variations and patterns would be discussed in future.

7. References:

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