Formation of Perioesophageal Plexus Gulae and Anterior and Posterior Vagal Trunks in South Indian Population: A morphological study

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ABSTRACT

Background and Aim of the study: Vagus the wanderer is the tenth cranial nerve with long extra cranial course. Below the bifurcation of trachea, the right and left vagi form plexus around the oesophagus before they enter the abdomen as anterior and posterior vagal trunks. There are variations in the contribution by the right and left vagi for the formation of oesophageal plexus and according to Chamberlin and Winsip there are three different patterns in the formation of peri oesophageal plexus. The present study was aimed to study the formation of perioesophageal plexus, incidence of different patterns of peri oesophageal plexus in south Indian population and the number of vagal trunks formed from the oesophageal plexus in the lower end of the oesophagus. Materials and Methods: The formation of perioesophageal plexus Gulae was studied in forty four autopsy specimens of oesophagus and stomach and six foetal specimens at Institute of Anatomy, Madras Medical College, Chennai. Results: The formation of perioesophageal plexus and the number of fibres from the right and left vagus nerves which contribute to the plexus formation were studied. There were significant differences in the formation of plexus Gulae. There were variations in the pattern of perioesophageal plexus and the number of vagal trunks arising from the plexus. The results of the present study in South Indian population were compared with the results in the Western population. Conclusions: Awareness regarding the presence of plexus Gulae and number of vagal trunks related to lower end of oesophagus has considerable importance in the surgical repair of hiatus hernia and while treating atrial fibrillation.

Key words: Perioesophageal plexus, Oesophagus, Vagus nerve

INTRODUCTION

Vagus is the tenth cranial nerve which has the longest extra cranial course among the twelve cranial nerves. It is an important parasympathetic nerve which innervates many organs in the neck, thorax and abdomen1. The vagaries of vagus nerve had been of interest for several centuries2. It is the nerve that is responsible for the secretion of hydrochloric acid, the acid behind the commonest disease of the modern century, the Acid Peptic Disorder.

Supradiaphragmatically below the level of primary bronchus, the right and left vagus nerves form an open meshed plexus around the oesophagus called plexus Gulae3. From this plexus the anterior and the posterior vagal trunks are formed and enter the abdomen along with the oesophagus. According to Doubilet et al., this plexus has a constant basic structure contributed by both the vagal trunks4. According to Peden, Schneider and Bickel, the number of branches contributed by the vagus nerves varies from zero to five5. According to Chamberlin and Winsip, there are three patterns in the formation of this plexus. They are simple pattern, intermediate pattern and complex pattern6. In simple pattern, there is formation of single primary trunk from the anterior and posterior oesophageal plexuses. They form the anterior and posterior vagal trunks which enter the oesophageal hiatus as single trunks. In intermediate pattern, there is formation of single vagal trunks from anterior and posterior oesophageal plexuses but they divide in to two or more vagal trunks before entering oesophageal hiatus. In complex pattern, there is
formation of two or more primary vagal trunks from the anterior and posterior oesophageal plexuses irrespective of the number of vagal trunks entering the oesophageal hiatus.

The anterior vagal trunk arises from the anterior oesophageal plexus and the posterior vagal trunk arises from the posterior oesophageal plexus. According to Skandalakis et al., the number of vagal trunks entering the oesophageal hiatus varies from one to three.

The present work was aimed to study in detail about the formation of perioesophageal plexus, and the contribution by the right and left vagus nerves for its formation. The number of vagal trunks arising from the plexus which is related to lower end of oesophagus before it enters oesophageal hiatus has also been studied.

The right vagus nerve when it enters the abdomen forms the posterior vagal trunk and the left vagus nerve forms the anterior vagal trunk. The formation of perioesophageal plexus gives an insight to the formation of anterior and posterior vagal trunks and contribution by the right and left vagus nerves to their formation. Due to non availability of reports of similar studies on Indian population, the results of the present study were compared with the Western studies.

**MATERIALS AND METHODS**

Forty four autopsy specimens of oesophagus and stomach from the level of tracheal bifurcation along with the diaphragm and organs of supracoelic compartment were collected from Institute of Forensic Medicine, Madras Medical College, Chennai and six nine month old still born fetuses were collected from Institute of Obstetrics and Gynaecology, Madras Medical College, Chennai after getting ethical approval from the concerned departments. The autopsy specimens were preserved in 10% formalin and after fifteen days, studied by conventional dissection method. The foetal specimens were embalmed and preserved. After fifteen days, the trunk of the foetus was opened. The heart and lungs were removed to have a better access to the oesophagus. The peri oesophageal plexus was dissected and studied.

**OBSERVATIONS**

The connecting cords of the Right and Left Vagus nerves form the anterior oesophageal plexus and the posterior oesophageal plexus around the oesophagus. The number of fibres contributed by them varied from zero to five (Table 1).

The pattern of plexus formation as per Chamberlin and Winship are three, namely simple pattern, intermediate pattern and complex pattern.

<table>
<thead>
<tr>
<th>No of Branches</th>
<th>Anterior Oesophageal Plexus</th>
<th>Posterior Oesophageal Plexus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right Vagus</td>
<td>Left Vagus</td>
</tr>
<tr>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1. Contribution of right and left vagus nerves for the formation of Plexus Gulae
Anterior oesophageal plexus

Among the adult specimens, simple pattern was seen in 33 specimens (Fig.1), intermediate pattern in three specimens (Fig.2) and complex pattern in seven specimens (Fig.3). Among the foetal specimens, simple pattern was seen in five specimens (Fig.4) and intermediate pattern in one specimen.

Posterior Oesophageal Plexus

Among the adult specimens, simple pattern was seen in 34 specimens (Fig.5), intermediate pattern in four specimens and complex pattern in six specimens (Fig.6). Among the foetal specimens, the posterior oesophageal plexus showed simple pattern in five specimens (Fig.7) and complex pattern in one specimen. The different patterns of perioesophageal plexus formation is shown in Figures 8, 9 and 10.

The number of anterior vagal trunks varied from one to four and the number of posterior vagal trunks varied from one to two (Table.2). These findings were compared with the results of studies available in the literature.

DISCUSSION AND CONCLUSION

Schaffer et al. have documented the details of the formation of oesophageal plexus as early as 1909. Similar to the other studies available in the literature, it was observed that both the vagus nerves contributed to the formation of perioesophageal plexus. The present study also showed that the anterior oesophageal plexus was formed predominantly by left vagus nerve and the posterior oesophageal plexus was formed predominantly by right vagus nerve. The number of fibres contributed by the right and left vagus nerves for the plexus formation varied from zero to five and the commonest being one or two. It was observed that there was no contribution by the right vagus nerve and the anterior oesophageal plexus was formed by the left vagus alone in 12 specimens and there was no contribution by the left vagus nerve and the posterior oesophageal plexus was formed by the right vagus alone in seven specimens. The formation of perioesophageal plexus showed that there was sharing of fibres between the left and right vagus nerves. The plexus is formed in foetal life itself.

Though the commonest pattern in the formation of peri oesophageal plexus is simple, intermediate and complex patterns were also seen. According to Chamberlin and Winship, there is no apparent relationship between the sex of the individual, the body sizes and the pattern of the vagus nerves and peri oesophageal plexus.

<p>| Table 2. Number of anterior and posterior vagal trunks at the oesophageal hiatus of diaphragm |
|---------------------------------|---------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th><strong>No. of Trunks</strong></th>
<th><strong>Mitchell (1940)(n-15)</strong></th>
<th><strong>Doubilet (1948)(n-32)</strong></th>
<th><strong>Skandalakis (1974)(n-100)</strong></th>
<th><strong>Mackay (1983)(n-31)</strong></th>
<th><strong>Present Study</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anterior Vagal Trunks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10</td>
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<td>88</td>
<td>30</td>
<td>35</td>
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<td>0</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Posterior Vagal Trunks</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>8</td>
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<td>6</td>
<td>11</td>
<td>10</td>
<td>2</td>
<td>7</td>
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<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Fig. 1: shows the formation of simple pattern of anterior oesophageal plexus with single anterior vagal trunk.

Fig. 2: shows the formation of intermediate pattern of anterior oesophageal plexus with two anterior vagal trunks.

Fig. 3: shows the formation of complex pattern of anterior oesophageal plexus with two anterior vagal trunks.

Fig. 4: shows the formation of simple pattern of anterior oesophageal plexus with single anterior vagal trunk in Foetus.

Fig. 5: shows the formation of simple pattern of posterior oesophageal plexus with single posterior vagal trunk.

Fig. 6: shows the formation of complex pattern of posterior oesophageal plexus with two posterior vagal trunks.

Abbreviations: AVT-Anterior Vagal Trunk, D-Diaphragm, O-Oesophagus, AOP-Anterior Oesophageal Plexus, CAOP-Complex Anterior Oesophageal Plexus, TA-Thoracic Aorta, PVT-Posterior Vagal Trunk, POP-Posterior Oesophageal Plexus
Fig. 7: shows the formation of simple pattern of posterior oesophageal plexus with single posterior vagal trunk in Foetus.

Fig. 8. Simple pattern of anterior and posterior peri oesophageal plexus

Fig. 9. Intermediate pattern of anterior and posterior peri oesophageal plexus

Fig. 10. Complex pattern of anterior and posterior peri oesophageal plexus
The number of vagal trunks that come out from the perioesophageal plexus too showed considerable variations. Though the commonest was single trunk, three anterior vagal trunks were observed in two specimens and two posterior vagal trunks were observed in eight specimens. This is probably the major cause of recurrence of peptic ulcer when vagotomy is performed via thoracic route.

The organs below the diaphragm are supplied by both the vagus nerves since the perioesophageal plexus allows mixing of the right and left vagal fibres. This shows the complexity of the vagus the wanderer is not only seen in its course but in its distribution too.10

Awareness regarding the perioesophageal plexus of Gulae is very important clinically because reflex stimulation of this plexus in percutaneous radiofrequency ablation in atrial fibrillation causes acute pyloric spasm and gastric hypo motility.11 The knowledge regarding the presence of peri oesophageal plexus plays an important role in surgical repair of hiatus hernia.

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