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ORIGINAL RESEARCH

Incidence of vertebral ganglion in cervical sympathetic trunk

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ABSTRACT

Background: Cervical Sympathetic Trunk (CST) differs from other parts of the sympathetic chain in having only three ganglia corresponding to eight cervical spinal segments and the absence of white rami communicantes[1]. Awareness of the variations of CST helps the surgeon to identify and preserve it during surgical interventions of the neck, thus reducing CST injury. The purpose of present study is to introduce the incidence of vertebral ganglion other than the normal once. **Materials & Methods**: In this cross-sectional study, 50 cervical sympathetic trunks (chains) were studied by bilateral neck dissections of 25 formalin fixed adult human cadavers from the Department of Anatomy, Government Medical College Thrissur. **Results:** Superior cervical ganglion (SCG) was consistently seen in all sympathetic chains. Middle cervical ganglion (MCG) was present in 27 (54%) chains studied; Inferior cervical ganglion (ICG) was present in 38 (76%) CSTs. In case of stellate ganglion (SG), it was present in 12 (24%) chains. vertebral ganglion (VG) was present in 33 (66%) chains. Middle and vertebral ganglia co-existed in 10 cases. The most common type of CST consisted of SCG, VG and ICG (17, 34%). **Conclusions:** This study concludes that, in addition to the above-mentioned ganglia, VG was present in 33 specimens. Our study also emphasizes the need for awareness of the presence of vertebral ganglion in CST which is needed during cervical surgical procedures to prevent inadvertent injury to it.

Keywords: Cervical sympathetic chain, Cervical sympathetic trunk, Vertebral ganglia, Stellate ganglion, Sympathetic chain, Sympathetic trunk

INTRODUCTION

Cervical part of the sympathetic chain lies behind the carotid sheath and in front of the prevertebral fascia. It extends from the base of the skull up to the level of the neck of 1st rib, where it continues as the thoracic chain. Initially the number of sympathetic ganglia corresponds with the number of spinal nerves[2]. Later the upper four fuse to form superior cervical ganglion, 5th and 6th fuse to form middle and 7th and 8th join to form inferior cervical ganglion. Sometimes inferior cervical and first thoracic ganglion fuse to form a cervicothoracic or stellate ganglion.[3]

The development of the cervical sympathetic ganglia may get arrested at some stage and this leads to marked individual variations of the cervical sympathetic trunk in newborn, infants and adults. Based on this concept, Laubman[3] classified the cervical sympathetic chain to five types according to the number and position of ganglia. Telford[4] in 1935 noted the marked variability of the sympathetic trunk in the cervical region and stated that no two chains are alike in pattern

Mannu[5] described all ganglia between superior cervical ganglia and inferior cervical ganglia as "intermediate ganglia". Axford[6] observed two ganglia between the superior cervical and inferior cervical ganglia and referred to them as "high and low middle cervical ganglia". He described the lower one as a detached portion of the middle cervical ganglion. by Wrette M[7] has described an entity called" ganglionvertebrale" which was discussed under "ganglion cervical medium"

There is growing clinical significance of minimally invasive procedures owing to the occurrence and location of ganglia in CST. The MSG is sometimes damaged during surgery or various procedures such as neck lymph node biopsy, thoracoscopic cervical sympathectomy, anterior cervical spine surgeries, ultrasound guided neck procedures like stellate ganglion block, ethanol ablation, radio frequency ablation of thyroid tumours, etc. Vertebral ganglion is more common than middle cervical ganglion and is very close to its location. The present study aims to

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define MCG and VG by tracing its dimensions, position and frequency of occurrence.

METHODS

We conducted a cross-sectional study in the Department of Anatomy, Government Medical College Thrissur, Kerala over a period of 1.5 years from December 2016 to May 2018 on cadavers preserved for undergraduate medical education. All 25 cadavers used were males, belonging to Central Kerala, their age may be ranging from 25-60 years as most were unidentified bodies. 50 cervical sympathetic chains were studied by bilateral neck dissection. Sample size was worked out based on the result from the available literature on the prevalence of increased frequency of vertebral ganglion. The formula used was,4N=4□□/□2.

Inclusion criteria

All adult cadavers of normal gross morphology of the neck were included in the study.

Exclusion criteria

Cadavers with difficult exposure of cervical sympathetic chains were excluded.

Ethical considerations

Institutional research board (IRB) approval was obtained before starting the study.

Study procedure

The cervical sympathetic chain was dissected out from the base of the skull to the neck of the second rib as per instructions in Cunningham's practical manual of anatomy. The Cervical Sympathetic Chain was exposed to locate superior, middle and inferior sympathetic ganglia. Variations like size, shape, location of all cervical ganglia, the presence of accessory ganglia and their relations with adjacent structures were noted. All findings were photographed, and the data were documented.

Statistical analysis

Master chart was prepared in Microsoft office excel 2007 worksheet and statistical analysis done using SPSS software version 20.

RESULTS

Most of the studies conducted in this field show the correlation of MCG and VG. I will be discussing only these aspects

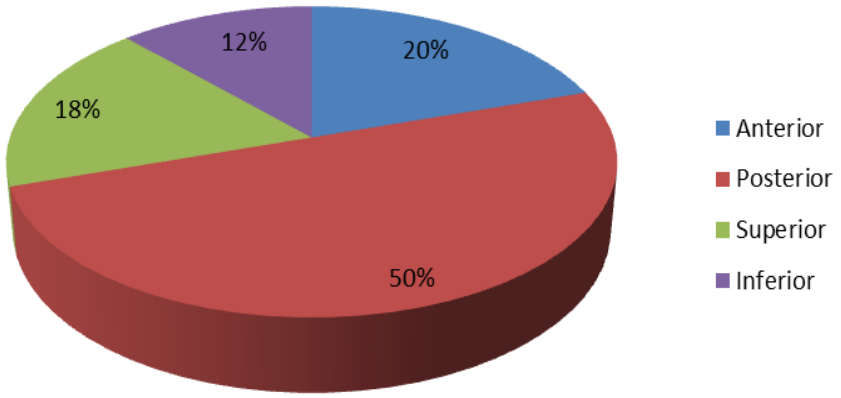
MIDDLE CERVICAL GANGLION

MCG was seen only in 27 cases. The mean length of MCG was 5.7mm ranges from 3 to 9 mm, breadth was 1.74 mm ranges from 1 to 3 mm and average thickness was 1.22mm ranges from 1 to 2 mm.

Table 1: Measurements of MCG

	Length(mm)	Breadth(mm)	Thickness(mm)
Mean	5.7	1.74	1.22
Standard deviation	1.81	0.76	0.08
Maximum value	9	3	2
Minimum value	3	1	1

In all cases MCG was closely related to Inferior thyroid artery anteriorly, posteriorly superiorly or inferiorly



Pie chart 1: Relations of MCG with inferior thyroid artery.

The shape of MCG varies from oval (17) irregular (4) fusiform (4) and round (2). Kasley et al[8] mentioned the shape of MCG as oval in 54.3% CSTs studied. In the present study 63% of the MCG were oval in shape.
Out of 27 specimens where MCG was present, it was located at the level of the 6th cervical vertebra in 11 cases. In 8 cases it was seen at the level of C5. It was seen at the level of C5- C6 level and C6- C7 level in 3 cases each. Only in one case MCG was found at the level of C7 vertebra.

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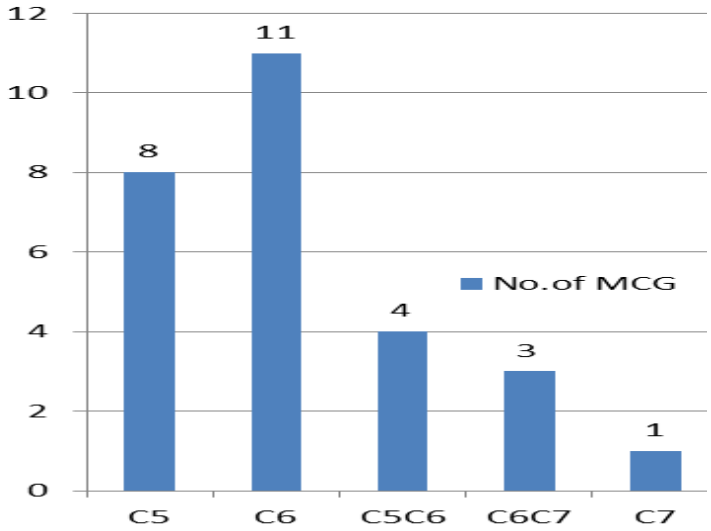


Bar chart 1: Location of MCG in relation to cervical vertebra

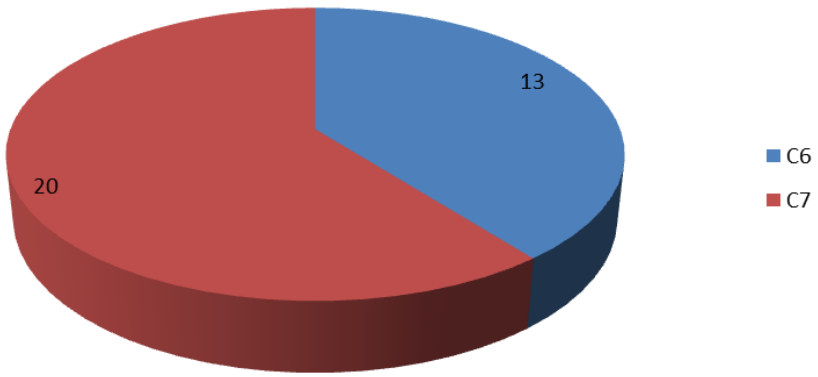
VERTEBRAL GANGLION

The vertebral ganglion was present in 33 cases. The average length was 8.87 mm with a standard deviation 2.04 and ranges from 5mm to 12 mm, the breadth was 4.39 mm ranges from 2 to 9 mm and the average thickness was 1.9 mm ranging from 1 mm to 4mm.The shape of ganglion was irregular in all 33 cases. The frequent location of vertebral ganglion was at the level of C7 vertebral body. In 100% of cases, it was closely related to the vertebral artery and forming a plexus over it. This finding was consistent with that of previous study of Becker et al and Wrete.[9,7]

Table 2: Measurements of VG

	Length(mm)	Breadth(mm)	Thickness(mm)
Mean	8.87	4.39	1.9
Standard deviation	2.04	1.86	0.76
Maximum value	12	9	4
Minimum value	5	2	1

Vertebral level of vertebral ganglion: In 20 cases it was at the level of C7 vertebra and in 13 cases it was at the level of C6 vertebra



Pie chart2: Position of vertebral ganglion in relation to cervical vertebra

MIDDLE CERVICAL GANGLION AND VERTEBRAL GANGLION

The MCG was present only in 54% CSTs. Sheehan et al[10,] Kuntz A.[11]and Mitchell[12] mentioned absence of MCG in CST. Though Laubmann et al[3] observed the fused SCG and MCG named as medio-superior cervical ganglion, we didn't get such a pattern.

VG was present in 66% CSTs and more frequent than MCG. Sheehan et al[10] reported the increased frequency of VG than MCG in their works. A. Kiray et al[13] observed the middle ganglion and vertebral ganglion were each observed in 33.3%. An apparent fusion between VG and MCG was mentioned in an earlier study done by Laubmann et al[3] in 2% chains, known as medio-vertebral cervical ganglion which was also seen in the present study in 4% chains.

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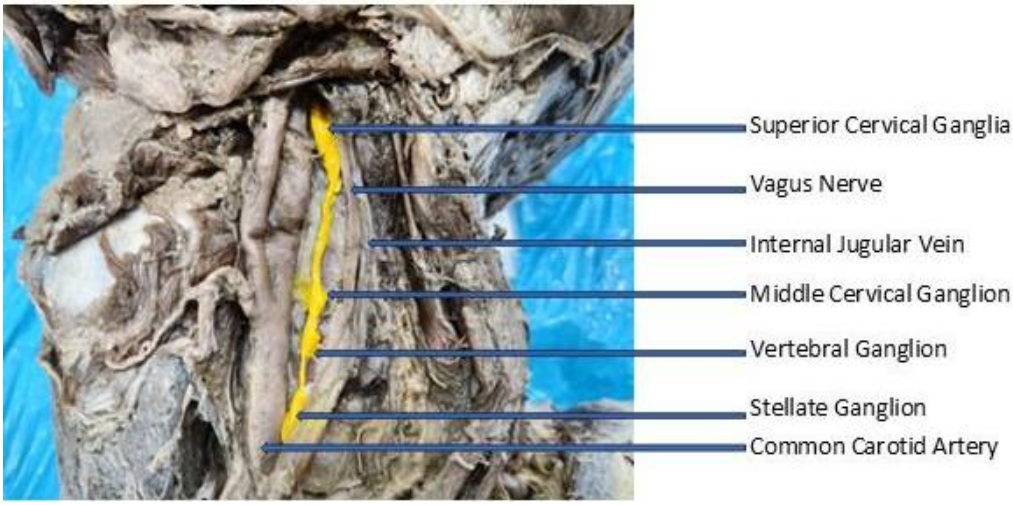
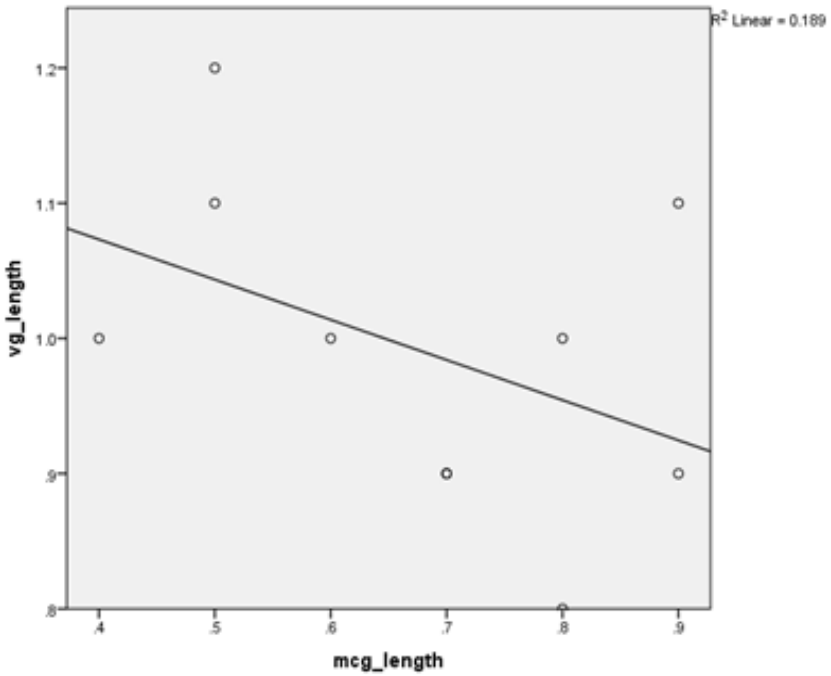


Diagram 1: CST with SCG, MCG, VG and Stellate Ganglion

MCG and VG did not co-exist in the majority of the cases. Only in 10 cases both MCG and VG are co-existed. MCG- VG occurrence chart: A correlation study of length and breadth of MCG with VG has been done.



Scatter diagram 1: showing MCG length and VG length

A correlation between length of MCG and VG was obtained and it was negative with correlation coefficient r=0.435 and p value=0.05.

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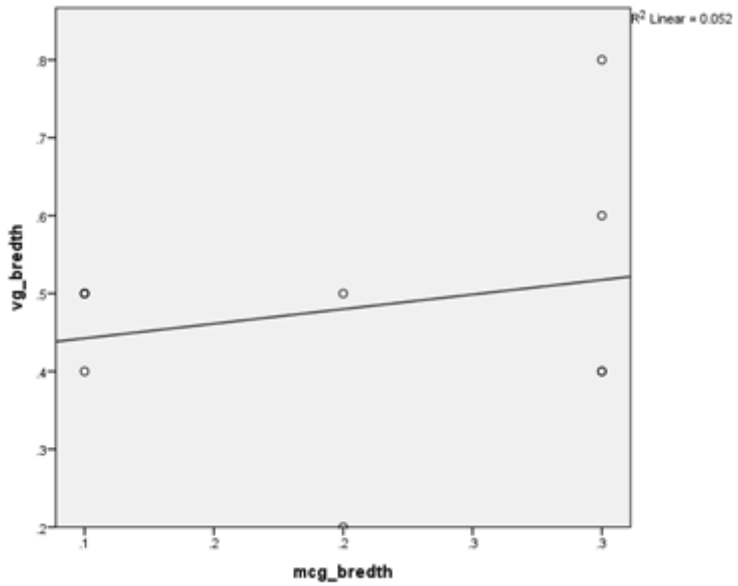

Scatter diagram 2: showing MCG breadth and VG breadth

A correlation between breadth of MCG and VG was obtained and it was negative with correlation coefficient r=0.228 and p value=0.05. In both cases, there is a relation between MCG and VG but it is negative, and it is statistically not significant.

DISCUSSION

The result of this research gives important data regarding cervical sympathetic trunk anatomical variations with particular interest in the incidence and nature of the vertebral ganglion (VG) and the middle cervical ganglion (MCG). Understanding these variations is crucial, especially for clinical and surgical interventions of the cervical region, because the accidental injury of these structures can result in complications that include disturbed autonomic functions.

The study found that the superior cervical ganglion (SCG) was invariably found in each case, which highlighted its anatomical predictability. The MCG, on the other hand, was found in just 54% of the cervical sympathetic trunks (CSTs), which shows a notable variation in its presence. The vertebral ganglion, on the other hand, was found in 66% of cases, which is more common than that of the MCG. This finding is in accordance with the results of previous studies, such as those of Sheehan et al., who also reported a higher frequency of VG compared to that of MCG. The variations in the presence of MCG and VG suggest that their formation may be influenced by embryological fusion patterns and the presence of intermediate ganglia.

The dimensions of the MCG in this study had a mean length of 5.7 mm (3 to 9 mm), mean width of 1.74 mm, and mean thickness of 1.22 mm. The morphology varied, but they were predominantly (63%) oval, while the rest were irregular, fusiform, or spherical. These compare with findings from other studies, e.g., Kasley et al., in which the MCG was oval in 54.3% of the cases. The anatomical location where the MCG occurred was also varied, and most of them occurred at C6, with one occurring at C5. This anatomical variation is aimed at emphasizing the need for attention during surgery when accessing the cervical region to avoid unnecessary damage.

The vertebral ganglion had a higher prevalence than the MCG, occurring in 66% of the cases. The mean VG length was 8.87 mm, with a range of 5 to 12 mm, while the mean breadth and thickness were 4.39 mm and 1.9 mm, respectively. Unlike the MCG, which had variable shapes, the VG was always irregular in shape. Its frequent location at the level of the C7 vertebral body and its close relationship to the vertebral artery underscore its clinical relevance. The anatomical location in this regard means that surgical procedures on the vertebral artery, such as anterior cervical spine procedures, could compromise the VG. Previous reports by Becker et al. and Wrette have also confirmed the close association of the VG with the vertebral artery, corroborating the findings of the present study. One of the most important areas of research in the study was the research into whether MCG and VG co-occur or not. The two ganglia co-occurred in just 20% of the cases, i.e., their occurrence is independent of one another. Statistical comparison of correlation between the length and the width of MCG and VG yielded a negative correlation, meaning that the variation in the size of one ganglion does not influence the other. This also verifies the hypothesis that the development of the ganglia is along independent embryological lines.

The results of the current study concur with the results of earlier studies and, besides, offer new information on cervical sympathetic ganglia variability. The prevalence rate of MCG and VG in the current study is consistent with the findings of researchers like Becker and Grunt, Pick and Sheehan, and Raveendran et al. Minor difference in prevalence rates among

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studies may be due to sample size, population, or dissection method.

Clinically, these differences concern the surgeons undertaking procedures such as thoracoscopic sympathectomy, anterior cervical spine surgery, and nerve blocks. Injury to the cervical sympathetic ganglia could lead to such conditions as Horner's syndrome, vascular dysfunctions, or other autonomic disorders. Due to the more common presence of the vertebral ganglion, surgeons need to be careful while targeting the region during procedures, particularly in relation to the vertebral artery. Last but not least, the research highlights the importance of understanding the anatomical differences of the cervical sympathetic trunk, most importantly the frequency and morphology of the vertebral and middle cervical ganglia. The higher frequency of VG compared to MCG suggests that it should be given consideration as a significant structure when performing surgery in the cervical region. Understanding these anatomical differences can minimize surgical complications and improve patient outcomes.

CONCLUSION

In this study, we found four distinct ganglia along the cervical sympathetic chain. Vertebral ganglion at the level of 7th cervical vertebra was more frequently observed than middle cervical ganglion at 6th cervical vertebral level.

Table 3: Frequency of occurrence of Middle cervical and Vertebral ganglia in various studies

	No. of CSTs	Total CST with MCG (%)	Total CST with VG (%)	Only MCG (%)	Only VG(%)	MCG+ VG (%)
Pick and Sheehan [10] (1946)	25	56	36	28	8	28
Jamieson et al [14](1952)	100	-	-	64	36	-
Becker and Grunt [9](1957)	114	62.3	87.7	7	32.4	55.3
Canon Y et al [15] (2009)	40	-	-	48	8	-
Kiray et al[13](2017)	24	-	-	33.3	33.3	-
Raveendran VL et al[16](2018)	50	44	72	22	50	22
Present study	50	54	66	34	46	20

The size of the vertebral ganglion is not related to MCG statistically. Clinicians should be aware of the more constant existence of vertebral ganglion over vertebral artery to prevent iatrogenic trauma during surgical procedures.

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