Anatomical Variations of the Ansa Cervicalis in Thais

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Abstract : **The aim of this study was to examine the variation of ansa cervicalis in Thais in terms of its origin, formation and relation to the great vessels of the neck. Anatomical dissections were examined bilaterally in 108 cervical plexuses of Thai cadavers ranging in age from 34 to 87 years. There were 57 male and 51 female cervical plexuses. The ansa cervicalis which consists the first to third cervical ventral rami (C_1-C_3), is formed by the junction of the superior and inferior roots. Its anatomical course and morphology are complicated by the variable lengths, origins, and relations with the great vessels of the neck. Twenty types of ansa cervicalis were classified into 5 different groups according to the length of ansa loop as compared with the level of cricoid cartilage and the relation of the inferior root of the ansa to the internal jugular vein. Depending on the origins of the inferior and superior roots, each group consisted of various types. Group I and II had long ansa loops with the inferior root lying lateral to the internal jugular vein in group I, and medial to the vein in group II. Similarly, group III and IV had short loops of the ansa with the inferior root lying lateral to the internal jugular vein in group III, and medial to the vein in group IV. However, group V was not related to the criteria. It was suggested that the majority of ansa cervicalis were found to be group IV and group I. The variation of ansa cervicalis patterns occurred in both sides. This was not statistically different with regard to either gender or side. The results of this study provide additional information and new insights into the variation of the ansa cervicalis which may have useful applications in laryngeal reinnervation surgery and anesthesia.**

Key words **:** Ansa cervicalis, Cervical plexus, Anatomy, Variation, Thais

เรื่องย่อ : **ความหลากหลายของแอนสาเซอร์วิคาลิสในคนไทย**

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ศึกษาความหลากหลายของแอนสาเซอร์วิคาลิสในคนไทยในแง่กำเนิด รูปแบบ และความสัมพันธ์กับหลอดเลือดใหญ่บริเวณคอ โดยการชำแหละโครงข่ายประสาทเซอร์วิคอลทั้งสองข้างในคนไทย จำนวน 108 โครงข่าย จากร่างอาจารย์ใหญ่ที่มีช่วงอายุ 34-87 ปี ประกอบด้วยโครงข่ายประสาทเพศชาย จำนวน 57 โครงข่าย

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และเพศหญิง จำนวน 51 โครงข่าย จากการศึกษาพบว่าแอนสาเศอร์วิคาลิส มีกำเนิดมาจากแขนงหน้าของประสาทไขสันหลังส่วนคอคู่ที่ 1-3 โดยการต่อกันของรากบนและรากล่าง ทางเดินและรูปแบบของแอนสาเศอร์วิคาลิสมีความหลากหลายในด้านความยาว กำเนิด และความสัมพันธ์กับหลอดเลือดดำบริเวณคอ แอนสาเศอร์วิคาลิส พบทั้งหมด 20 แบบ แบ่งออกได้เป็น 5 กลุ่ม โดยใช้หลักเกณฑ์ของความยาวของห่วงแอนสาเศอร์วิคาลิสเมื่อเปรียบเทียบกับระดับกระดูกอ่อนคริคอยด์ และความสัมพันธ์ของรากล่างกับหลอดเลือดดำอินเทอร์นอลจูกูล่าร์ ซึ่งในแต่ละกลุ่มนั้นยังประกอบด้วยแบบย่อย ๆ หลายแบบขึ้นอยู่กับกำเนิดของรากบนและรากล่าง กล่าวคือ กลุ่มที่ 1 และกลุ่มที่ 2 มีลักษณะคล้ายกันคือห่วงของแอนสาเศอร์วิคาลิส ยาว แต่สิ่งที่แตกต่างกันคือ ในกลุ่มที่ 1 รากล่างวางตัวอยู่นอกต่อหลอดเลือดดำอินเทอร์นอลจูกูล่าร์ ส่วนกลุ่มที่ 2 รากล่างวางตัวอยู่ในต่อหลอดเลือดดำอินเทอร์นอลจูกูล่าร์ ทำนองเดียวกันกลุ่มที่ 3 และกลุ่มที่ 4 มีลักษณะคล้ายกันคือห่วงของแอนสาเศอร์วิคาลิส สั้น แต่สิ่งที่แตกต่างกันคือ ในกลุ่มที่ 3 รากล่างวางตัวอยู่นอกต่อหลอดเลือดดำอินเทอร์นอลจูกูล่าร์ ส่วนกลุ่มที่ 4 รากล่างวางตัวอยู่ในต่อหลอดเลือดดำอินเทอร์นอลจูกูล่าร์ อย่างไรก็ตามในส่วนของกลุ่มที่ 5 นั้นไม่มีความสอดคล้องกับหลักเกณฑ์

โดยสรุปแอนสาเศอร์วิคาลิสที่พบส่วนใหญ่จะเป็นแบบกลุ่มที่ 4 และกลุ่มที่ 1 ความหลากหลายในรูปแบบของแอนสาเศอร์วิคาลิส ไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติทั้งในระหว่างเพศหรือข้าง ผลจากการศึกษานี้ทำให้ได้ข้อมูลเกี่ยวกับความหลากหลายของแอนสาเศอร์วิคาลิส ทั้งในด้านกำเนิด ทางเดิน ความยาวและรูปแบบของแอนสาเศอร์วิคาลิส ซึ่งจะเป็นข้อมูลประกอบในการผ่าตัดผู้ป่วยอัมพาตของกล่องเสียง และการวางยาสลบ

INTRODUCTION

There has recently been a proliferation technique utilizing the ansa cervicalis nerve to reinnervate the paralyzed larynx by nerve implantation or neuromuscular transfer.[1-6] The anatomical course and the morphology of the ansa cervicalis is complicated by the variable courses and locations it can have with respect to the great vessels of the neck, as well as the significant differences observed in the arrangement of its contribution and regional branching patterns. The ansa cervicalis, arising from the first, second and third cervical ventral rami (C_1-C_3) is formed by the superior root and inferior root at the front of the common carotid artery[7-10]. The superior root, which originates from loop C_1-C_2 joins the hypoglossal nerve for a short distance, then separates and descends to join the inferior root, which originates from C_2-C_3.[7,9] Occasionally this root emerges from C_1 after connecting with the hypoglossal nerve[11,12] or is derived entirely or in part from the vagus nerve.[8] Meanwhile, the inferior root is derived from the union of the second and third cervical ventral rami (C_2-C_3).[8,11] It passes downward on the lateral side of the internal jugular vein, crosses in front of this vein a little below the middle of the neck and joins the superior root in front of the common carotid artery.[12]

Although the ansa cervicalis and its branches have become the prime choice for nerve-muscle transplantation in laryngeal reinnervation,[13,14] the information currently available on its location and course is still controversial. The purpose of this study is to examine the variation of ansa cervicalis in terms of its origin, relationship to the great vessels of the neck and its formation. The influence of gender and side difference are also taken into consideration.

MATERIALS AND METHODS

Anatomical examination was conducted in 108 halves of formalin-embalmed cadavers at the Department of Anatomy, Faculty of Medicine Siriraj Hospital, Mahidol University. All preserved cadavers were Thais ranging in age from 34 to 87 years. Fifty-seven male cervical plexuses (28 left and 29 right plexuses), and 51 female cervical plexuses (26 left and 25 right plexuses) were dissected. The skin and fat of the neck were removed, then the platysma

muscle was separated and removed from the deep structures. The sternocleidomastoid muscle was carefully removed and the ansa cervicalis was located. Its course was followed. After exploring the ansa cervicalis, its origin, length, relative location to the internal jugular vein and formation were dissected. The different patterns of the ansa cervicalis were classified according to the length of the ansa loop as compared with the level of cricoid cartilage, the relationship of inferior root to the internal jugular vein, and the origin of the inferior and superior roots.

RESULTS

The ansa cervicalis usually found to be comprised of the first to third cervical ventral rami (C_1-C_3) but its origin varied, as it could be derived from the ventral rami of C_1-C_2, C_1-C_4, or C_2-C_3. It

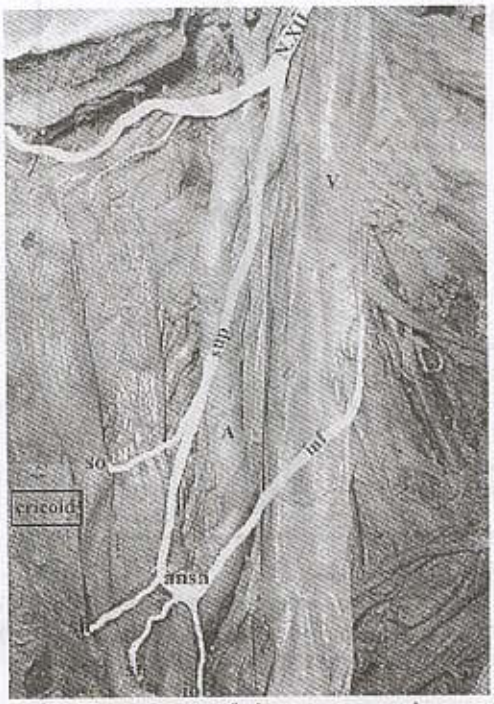

Figure 1. Photograph of the representative pattern of ansa cervicalis showing its origin, anatomical course, and morphology. The ansa cervicalis formed by the superior root and the inferior root at the front of the common carotid artery.
(A, common carotid a; Ansa, ansa cervicalis; cricoid, cricoid cartilage; Inf, inferior root; io, n. to inferior belly of omohyoid; N. XII, hypoglossal nerve; sh, n. to sternohyoid; so, n. to superior belly of omohyoid; st, n. to sternothyroid; Sup, superior root; V, internal jugular v.)

was formed by the junction of superior and inferior roots. The superior root that originated from loop C_1-C_2 joined the hypoglossal nerve for a short distance, then separated and descended to join the inferior root, which originated from C_2-C_3 (Figure 1). The anatomical course and the morphology of ansa cervicalis were complicated by the variable length, origination, and relation with the great vessels of the neck. Twenty different types of the ansa cervicalis were classified into 5 groups according to the length of the ansa loop as compared to the level of cricoid cartilage and the relationship of the inferior root of the ansa to the internal jugular vein. Depending on the origin of the inferior and superior roots, each group consisted of various types. Group I and II consisted of the ansa cervicalis with a long ansa loop. Group I had the inferior root lying lateral to the internal jugular vein and Group II had the root lying medial to the vein. Group III and IV consisted of the ansa cervicalis with a short loop of the ansa. Group III had the inferior root lying lateral to the internal jugular vein and group IV medial to the vein. However, group V was not related to the above mentioned criteria.

Group I consisted of the long ansa loop with its inferior root lying lateral to the internal jugular vein. It accounted for 38 of the cases (35.19%). Depending on the origin of inferior and superior roots, 4 types were classified (Figure 2). Type I-A, which was occurred in 22.22% and was the most common pattern, consisted of a long ansa loop with the inferior root coming from C_2-C_3 and lying lateral to the vein, and a superior root that originated from the loop of C_1-C_2. It joined the hypoglossal nerve for a short distance then separated and descended to join the inferior root. Three other types were similar to type I-A, with variations as follows: Type I-B: superior root originated from C_1; Type I-C: superior root from the union of C_1-C_2 and C_2 and the inferior root from C_3; Type I-D: superior root from the union of C_1-C_2 and C_3 and the inferior root from C_3-C_4.

Group II consisted of the long ansa loop with its inferior root lying medial to the internal jugular vein. It accounted for 5 of the cases (4.63%) and was classified into 2 types (Figure 3) as follows: Type II-A: the long ansa and the inferior root from C_2-C_3 lying medial to the vein. The superior root from loop of C_1-C_2, joined the hypoglossal nerve for a

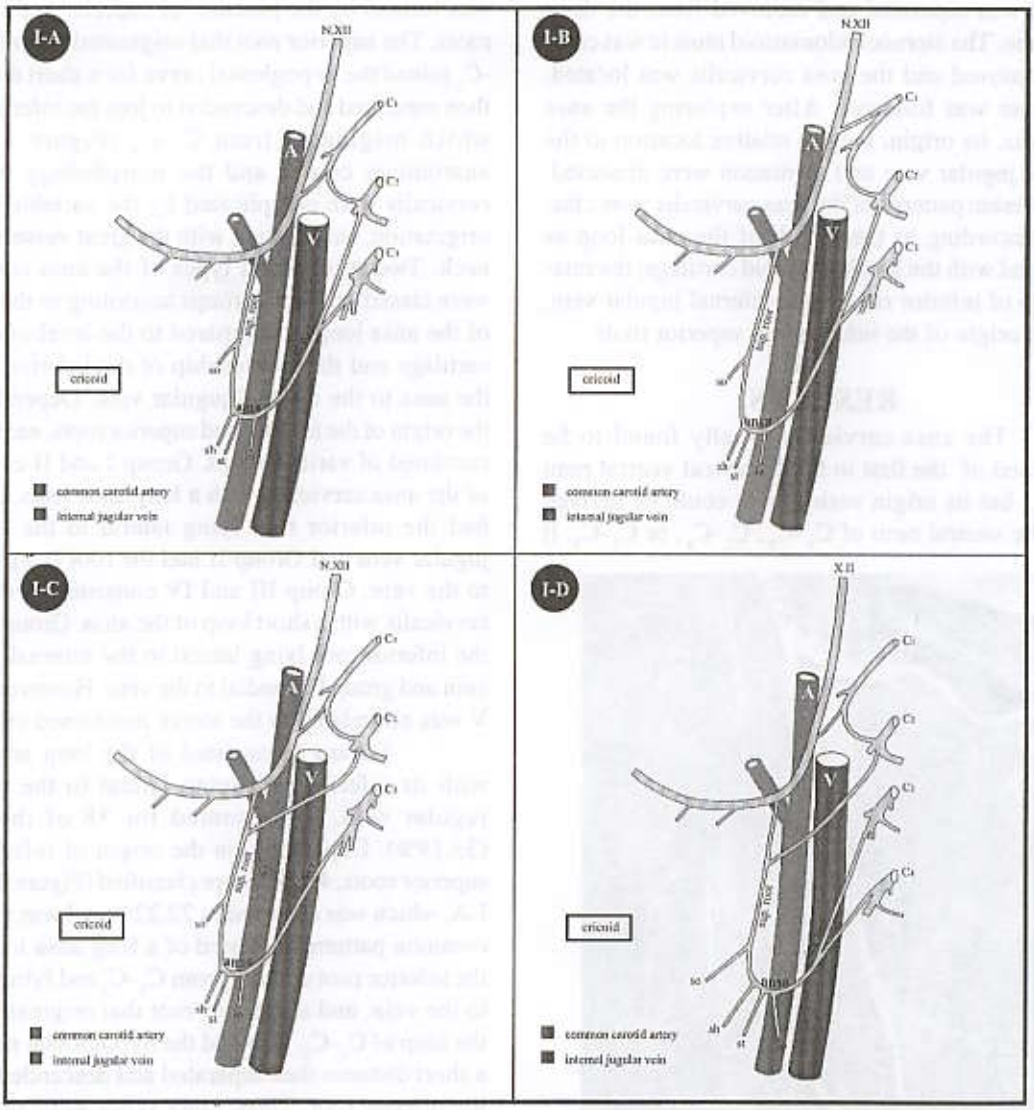

Figure 2. Diagram showing 4 different types of ansa cervicalis group I.
(A, common carotid a; Ansa, ansa cervicalis; C, cervical ventral rami; cricoid, cricoid cartilage; Inf root, inferior root; io, n. to inferior belly of omohyoid; N. XII, hypoglossal nerve; sh, n. to sternohyoid; so, n. to superior belly of omohyoid; st, n. to sternothyroid; Sup root, superior root; V, internal jugular v.)

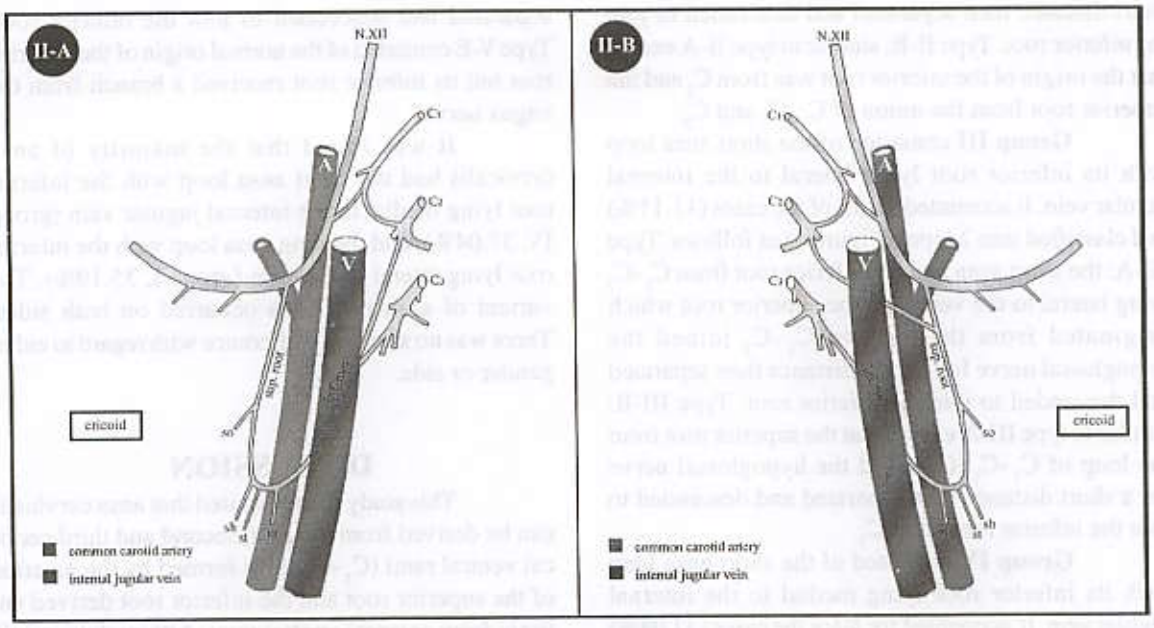

Figure 3. Diagram showing 2 different types of ansa cervicalis group II.
(A, common carotid a; C, cervical ventral rami; cricoid, cricoid cartilage; Inf root, inferior root; io, n. to inferior belly of omohyoid; N. XII, hypoglossal nerve; sh, n. to sternohyoid; so, n. to superior belly of omohyoid; st, n. to sternothyroid; Sup root, superior root; V, internal jugular v.)

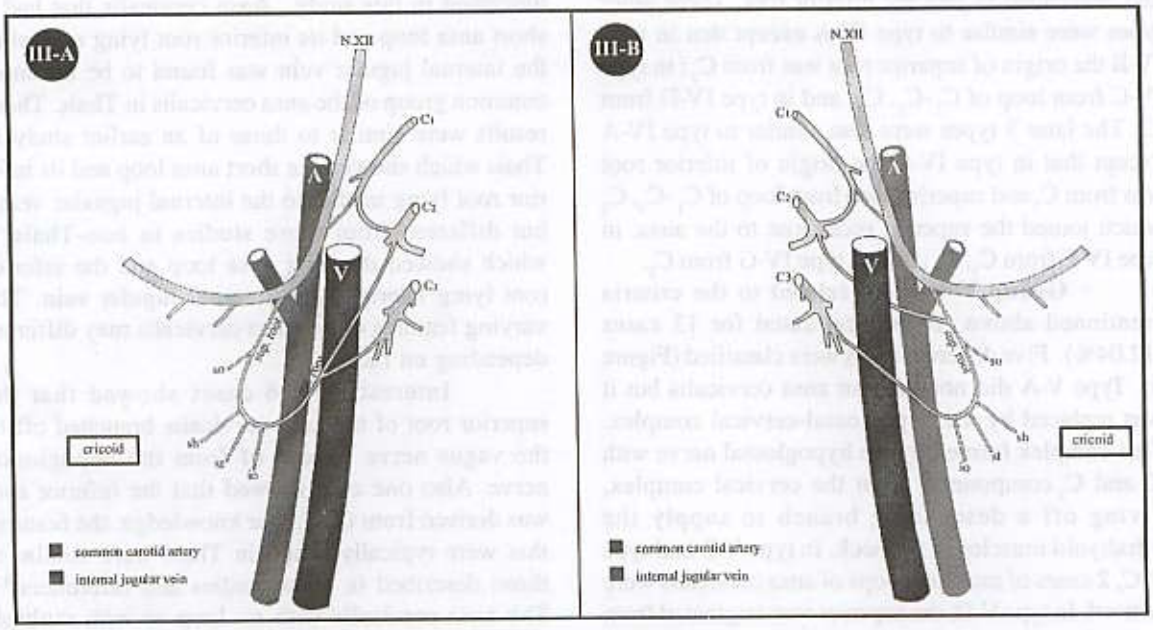

Figure 4. Diagram showing 2 different types of ansa cervicalis group III.
(A, common carotid a; C, cervical ventral rami; cricoid, cricoid cartilage; Inf root, inferior root; io, n. to inferior belly of omohyoid; N. XII, hypoglossal nerve; sh, n. to sternohyoid; so, n. to superior belly of omohyoid; st, n. to sternothyroid; Sup root, superior root; V, internal jugular v.)

short distance then separated and descended to join the inferior root. Type II-B: similar to type II-A except that the origin of the inferior root was from C_3 and the superior root from the union of C_1-C_2 and C_2.

Group III consisted of the short ansa loop with its inferior root lying lateral to the internal jugular vein. It accounted for 12 of the cases (11.11%) and classified into 2 types (Figure 4) as follows: Type III-A: the short ansa and the inferior root from C_2-C_3 lying lateral to the vein, and the superior root which originated from the loop of C_1-C_2 joined the hypoglossal nerve for a short distance then separated and descended to join the inferior root. Type III-B: similar to type III-A except that the superior root from the loop of C_1-C_2, C_2 joined the hypoglossal nerve for a short distance then separated and descended to join the inferior root from C_3.

Group IV consisted of the short ansa loop with its inferior root lying medial to the internal jugular vein. It accounted for 40 of the cases (37.04%) and was classified into 7 types (Figure 5). Type IV-A: the short ansa and the inferior root from C_2-C_3 lying medial to the vein, and the superior root which originated from the loop of C_1-C_2 joined the hypoglossal nerve for a short distance then separated and descended to join the inferior root. Three other types were similar to type IV-A except that in type IV-B the origin of superior root was from C_1; in type IV-C from loop of C_1-C_2, C_2; and in type IV-D from C_2. The later 3 types were also similar to type IV-A except that in type IV-E the origin of inferior root was from C_3 and superior root from loop of C_1-C_2, C_2 which joined the superior root close to the ansa; in type IV-F from C_1, C_2; and in type IV-G from C_2.

Group V was not related to the criteria mentioned above. These accounted for 13 cases (12.04%). Five different types were classified (Figure 6). Type V-A did not have an ansa cervicalis but it was replaced by the hypoglossal-cervical complex. This complex formed by the hypoglossal nerve with C_1 and C_2 components from the cervical complex, giving off a descending branch to supply the infrahyoid muscles of the neck. In type V-B and type V-C, 2 cases of multiple loops of ansa cervicalis were noticed. In type V-D, the superior root originated from loop of C_1-C_2 and joined vagus nerve instead of the hypoglossal nerve for a short distance, then it separated and descended to join the inferior root. Type V-E consisted of the normal origin of the superior root but its inferior root received a branch from the vagus nerve.

It was found that the majority of ansa cervicalis had the short ansa loop with the inferior root lying medial to the internal jugular vein (group IV, 37.04%), and the long ansa loop with the inferior root lying lateral to the vein (group I, 35.19%). The variant of ansa cervicalis occurred on both sides. There was no statistical difference with regard to either gender or side.

DISCUSSION

This study demonstrated that ansa cervicalis can be derived from the first, second and third cervical ventral rami (C_1-C_3). It is formed by the junction of the superior root and the inferior root derived entirely from cervical ventral rami. Although its origin was similar to those described in the previous studies,[7-10] the anatomical course, the origin of superior and inferior roots and the morphology of the ansa cervicalis were found to be varied and complicated. Twenty types of ansa cervicalis were classified and described in this study. Ansa cervicalis that had a short ansa loop and its inferior root lying medial to the internal jugular vein was found to be the most common group of the ansa cervicalis in Thais. These results were similar to those of an earlier study in Thais which showed the short ansa loop and its inferior root lying medial to the internal jugualar vein[15] but different from those studies in non-Thais[7-12] which showed the long ansa loop and the inferior root lying lateral to the internal jugular vein. The varying features of the ansa cervicalis may different depending on race.

Interestingly, 6 cases showed that the superior root of the ansa cervicalis branched off of the vagus nerve instead of from the hypoglossal nerve. Also one case showed that the inferior root was derived from C_2. To our knowledge, the features that were typically found in Thais were similar to those described in other studies and references.[8,12] The ansa cervicalis with no loop or with multiple loops found in this study has not previously been reported. In 1987, Sangvichien et al[15] revealed that

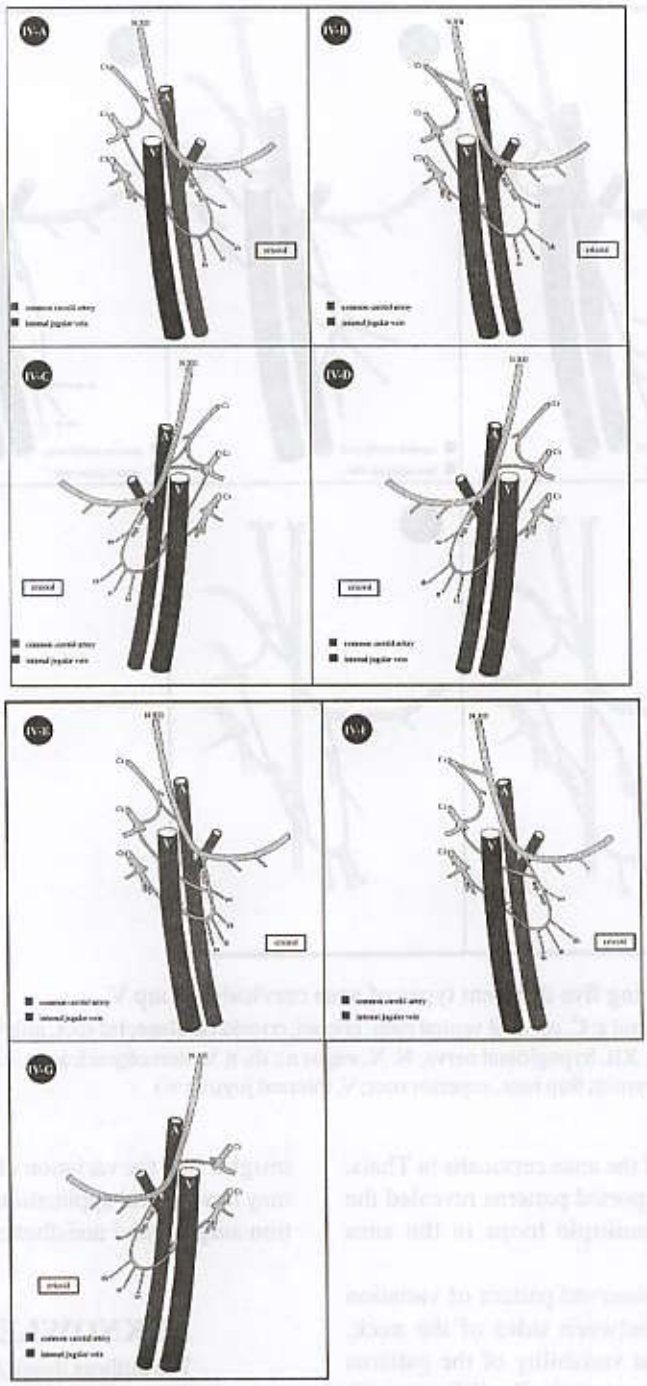

Figure 5. Diagram showing 7 different types of ansa cervicalis group IV.
(A, common carotid a; C, cervical ventral rami; cricoid, cricoid cartilage; Inf root, inferior root; io, n. to inferior belly of omohyoid; N. XII, hypoglossal nerve; sh, n. to sternohyoid; so, n. to superior belly of omohyoid; st, n. to sternothyroid; Sup root, superior root; V, internal jugular v.)

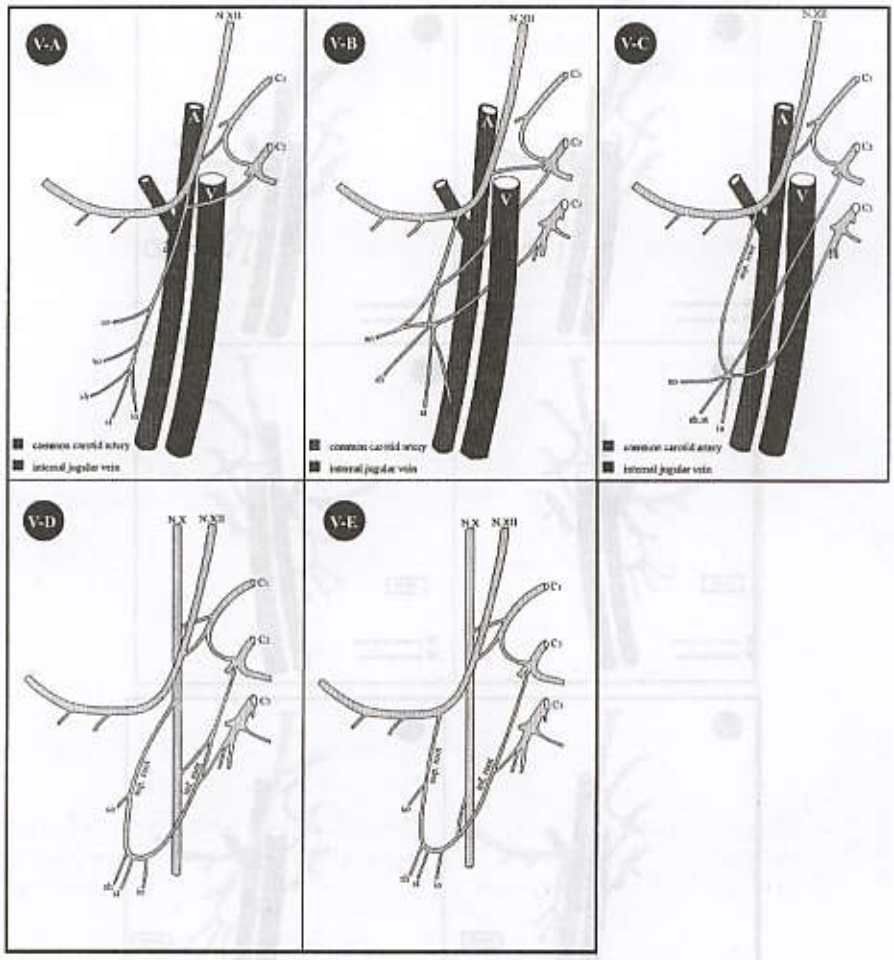

Figure 6. Diagram showing five different types of ansa cervicalis group V.
(A, common carotid a; C, cervical ventral rami; cricoid, cricoid cartilage; Inf root, inferior root; io, n. to inferior belly of omohyoid; N. XII, hypoglossal nerve; N. X, vagus n.; sh, n. to sternohyoid; so, n. to superior belly of omohyoid; st, n. to sternothyroid; Sup root, superior root; V, internal jugular v.)

there were 10 patterns of the ansa cervicalis in Thais. However, none of the reported patterns revealed the absence of a loop or multiple loops in the ansa cervicalis.

There was an observed pattern of variation in the ansa cervicalis between sides of the neck. However, the anatomical variability of the patterns of ansa cervicalis was not statistically different with regard to either side or gender. The results of this study provide additional information and further insights into the variation of the ansa cervicalis which may have useful applications for laryngeal reinnervation surgery and anesthesia.

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