



# Triangles of the neck: a review with clinical/surgical applications

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**Abstract:** The neck is a geometric region that can be studied and operated using anatomical triangles. There are many triangles of the neck, which can be useful landmarks for the surgeon. A better understanding of these triangles make surgery more efficient and avoid intraoperative complications. Herein, we provide a comprehensive review of the triangles of the neck and their clinical and surgical applications.

**Key words:** Neck, Anatomy, Triangle, Surgery, Landmarks

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## Introduction

The neck is limited superiorly by the inferior border of the mandible, anteriorly by midline, inferiorly by the superior border of the clavicle, and posteriorly by the anterior margin of the trapezius muscle. Many of the reported anatomical triangles of the neck have been depicted and mainly classified within the broader anterior and posterior cervical triangles (Fig. 1). The neck also contains such triangles as the suboccipital triangle in the posterior aspect of the neck, the triangle of the vertebral artery and scalene triangle in deep layer of the neck, Lesser's, Pirogov's, Béclard's, and Farabeuf's triangles [1, 2]. These anatomical triangles contain nerves, vessels, and other anatomical structures. Also, clinicians can easily identify some of these triangles and their contents with palpation, which provides valuable assistance as surface landmarks for clinical examination. The aim of this review is comprehen-

sively to revisit the anatomy of the triangles of the neck and to discuss their clinical applications.

## Anterior Triangle of the Neck

The anterior cervical triangle is bounded by the midline of the neck, the anterior border of the sternocleidomastoid muscle (SCM), and the inferior border of the mandible [3]. This triangle is typically subdivided into three paired and one unpaired triangle. The three paired triangles are the submandibular (digastric), carotid, and muscular triangles. The unpaired triangle is the submental triangle.

### *Submandibular (digastric) triangle*

The anterior and posterior borders of the submandibular triangle are the anterior and posterior bellies of the digastric muscle, respectively, and the base is the inferior border of the mandible. The floor of this triangle is formed by the mylohyoid muscle. The attachment of the mylohyoid muscle onto the mandible is more inferiorly in the anterior region and more superiorly in the posterior region of the triangle. For this reason, odontogenic inflammation caused by lower molar tooth infection, especially the wisdom teeth, could easily spread below the mylohyoid muscle into the submandibular space.

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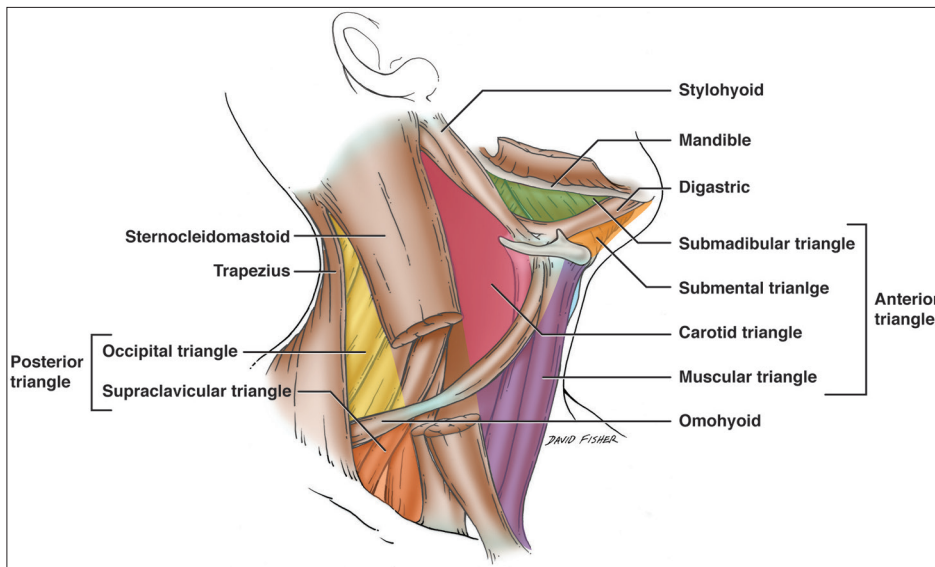


Fig. 1. Schematic drawing of the triangles and anatomical structures in the right neck.

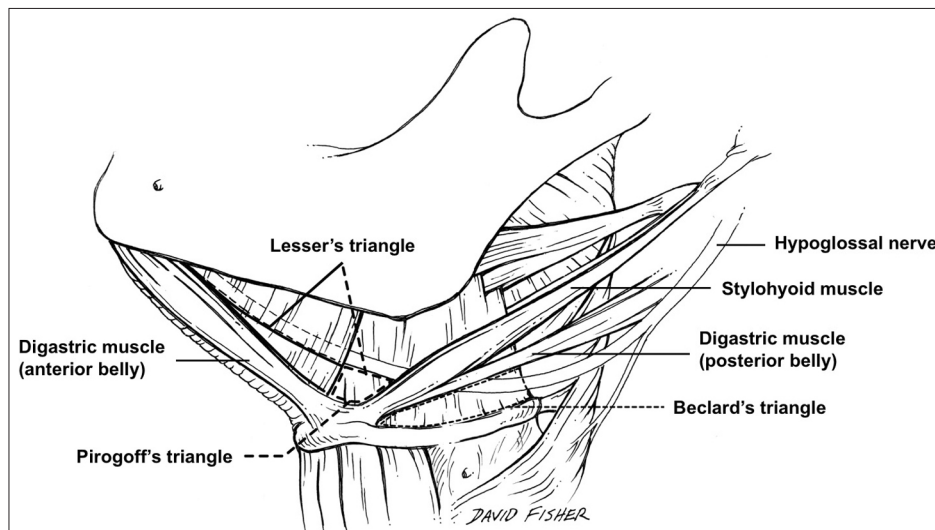


Fig. 2. Schematic drawing of Bécclard's, Lesser's, and Pirogov's triangles in the left neck. Modified from Tubbs et al. Surg Radiol Anat 2011;33:53-7 [2], with permission of R. Shane Tubbs holds the copyright.

This triangle usually contains the marginal mandibular branch of the facial nerve (MMB), the facial and lingual arteries and veins, the submandibular gland and lymph nodes, the nerve to the mylohyoid, the hypoglossal nerve, and the lower pole of the parotid gland. The submandibular incision to access to this triangle, e.g., abscess drainage and submandibulectomy, should be inferior to the MMB. Davies et al. [4] suggested that an incision two fingers-breadth below the inferior border of the mandible would provide safer access to the submandibular triangle than the 2 cm line below the inferior border of the mandible in order to avoid injury to the MMB.

Three small triangles are included inside the submandibular triangle: Lesser's, Pirogov's, and Bécclard's triangles (Figs. 2, 3) [2].

#### Lesser's triangle

Lesser's triangle is named after Ladislaus Leon Lesser (1846–1925), a German surgeon. It is bounded by the anterior and posterior bellies of the digastric muscle and the hypoglossal nerve [5]. This triangle has also been called the lingual triangle [6]. The most important structure in it is the lingual artery [6, 7]. The floor of Lesser's triangle is the hyoglossus muscle, and the lingual artery is found beneath it. Tubbs et al. [2] reported that Lesser's triangle was present in 30 out of 34 sides and absent on four. When it was absent, the hypoglossal nerve coursed inferior to the digastric muscle. Lesser's triangle, it is an ideal location for accessing the lingual artery, especially to control severe hemorrhage in the oral floor when it is injured [7, 8]. The lingual foramen is where the sublingual

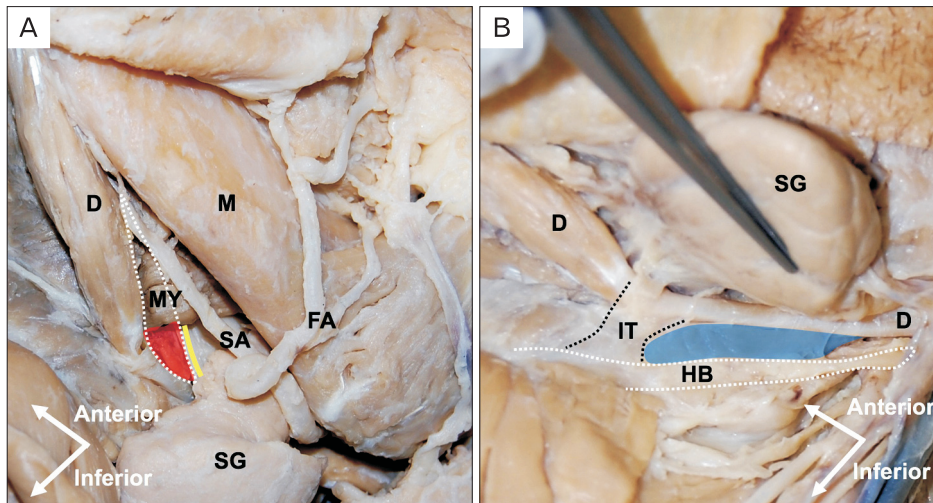


Fig. 3. Lateral view of the left neck on a formalin-fixed cadaveric dissection (region of the submandibular triangle). (A) White dotted line is Lesser's triangle, and red highlighted area is Béclard's triangle. (B) Blue highlighted area is Pirogov's triangle. D, digastric muscle; FA, facial artery; HB, hyoid bone; IT, intermediate tendon of digastric muscle; M, mandible; MY, mylohyoid muscle; SA, submental artery; SG, submandibular gland.

or submental artery enters the mandible [9].

#### *Pirogov's triangle*

Pirogov's triangle, named after Russian surgeon and scientist Nikolai I. Pirogov (1810–1881) who first described it, is bounded by the hypoglossal nerve superiorly, the intermediate tendon of the digastric muscle inferoposteriorly, and the posterior border of the mylohyoid muscle anteriorly [10]. This triangle is simply the posterior part of Lesser's triangle. Previous literature has referred to Pirogov's triangle as Pin-aud's triangle or the hypoglossohyoid triangle [6]. Pirogov's triangle is also an attractive location for performing a microvascular anastomosis using the artery [11]. Tubbs et al. [2] studied Pirogov's triangle using formalin-fixed cadavers and found it in 88.2% (30/34 sides). When it was absent, the hypoglossal nerve coursed below the digastric muscle, as with Lesser's triangle [2]. This triangle constantly included the lingual artery deep to the hyoglossus muscle. Homze et al. [12] reported that the Pirogov's triangle was present in 58.2% (53/91 sides) in their study using formalin-fixed cadavers. The lingual artery was located inferior to the superior border of the intermediate tendon of the digastric muscle in 67% (61/91 sides) and superior to it in 33% (30/91 sides) [12]. This study concluded that the lingual artery and hypoglossal nerve were located more inferiorly than classically reported.

#### *Béclard's triangle*

The boundaries of Béclard's triangle, named after the French anatomist Pierre A. Béclard (1785–1825), are the posterior belly of the digastric muscle, the posterior border of the hyoglossus muscle, and the greater horn of the hyoid bone [2,

13]. Tubbs et al. [2] examined Beclard's triangle and found it in 82.4% (28/34 sides). With absent, the reasons were that the posterior belly of the digastric muscle did not attach to the hyoid bone, or directly located just above the greater horn of the hyoid bone. Béclard's triangle constantly included both the lingual artery and hypoglossal nerve. Based on this result, Béclard's triangle could be a convenient landmark for identifying both anatomical structures.

#### *Carotid triangle*

The carotid triangle is bordered by the posterior belly of the digastric muscle, the superior belly of the omohyoid muscle, and the anterior border of the SCM. The floor and medial wall of this triangle is formed by the hyoglossus, thyrohyoid, and inferior and middle pharyngeal constrictor muscles. In the normal position, the inferior border of this triangle reaches the level of the carotid tubercle (anterior tubercle of the transverse process of the C6). The carotid triangle includes the common carotid artery and its bifurcation into the external carotid artery (ECA) and internal carotid artery (ICA). It usually contains the superior thyroid, lingual, facial, occipital, and ascending pharyngeal arteries. The superior thyroid, lingual, facial, ascending pharyngeal, and occipital veins accompany with these arteries, and all of them drain into the internal jugular vein (IJV). The hypoglossal nerve travels across the ECA and ICA. The external and internal branches of the superior laryngeal nerve arising from the vagus nerve can be identified medial to the ECA below the hyoid bone.

#### *Farabeuf's triangle*

Farabeuf's triangle, named for the French surgeon Louis-

Hubert Farabeuf (1841–1910), is a small triangle included within the carotid triangle. The boundaries of this triangle are the IJV, the common facial vein, and the hypoglossal nerve and direct its base superiorly (Fig. 4) [14]. Tubbs et al. [1] reported that Farabeuf's triangle was present in 75% (15/20 sides). This triangle was constantly located within the carotid triangle and included at least one of the branches of the common carotid artery on 14 out of 15 sides. The carotid bifurcation was contained within this triangle on two sides, meanwhile, the bifurcation was located inferior to this triangle on 13 sides. Moreover, these authors revealed that the common facial vein was located 1.5 cm inferior to the carotid bifurcation at the least, up to 2 cm superior. A jugulodigastric node was observed on eight sides. Earlier publications discussed the importance of Farabeuf's triangle during neck dissection [7, 14]. Campbell [15] also mentioned that "this triangle is a helpful landmark in extensive dissections of the neck, especially in locating the IJV, the safety of which is best conserved by promptly exposing it."

### Muscular triangle

The anterior border of the muscular triangle is the midline of the neck from the hyoid bone to the sternum. Its inferoposterior border is the anterior margin of the SCM and its posterosuperior border is the superior belly of the omohyoid muscle. This triangle includes the sternohyoid, sternothyroid,

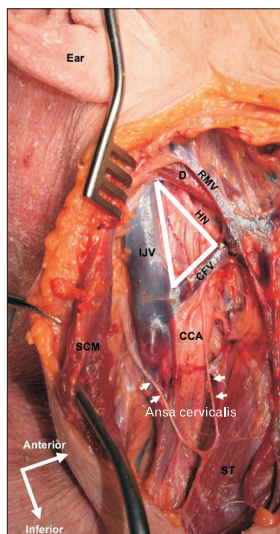


Fig. 4. Farabeuf's triangle of the right lateral neck on a fresh-frozen cadaver dissection (white solid line). CCA, common carotid artery; CFV, common facial vein; D, digastric muscle; HN, hypoglossal nerve; IJV, internal jugular vein; RMV, retromandibular vein; SCM, sternocleidomastoid muscle; ST, sternothyroid muscle.

omohyoid, and thyrohyoid muscles, and also the superior thyroid artery, the anterior jugular and inferior thyroid veins, and the ansa cervicalis [16]. The anterior cervical, infrahyoid, prelaryngeal, thyroid, pretracheal, paratracheal lymph nodes can also be found in this triangle. Its medial part includes the esophagus, trachea, thyroid gland, and the lower part of the larynx. Tracheostomy and thyroidectomy are invasive surgeries that access this triangle. Complications related to both procedures include bleeding [17, 18]. Injury of the superior thyroid artery can result in bleeding during surgery.

### Submental triangle

The submental triangle is unpaired and bounded by the anterior bellies of both digastric muscles and the body of the hyoid bone. Its floor consists of the mylohyoid muscle. It contains submental lymph nodes that receive lymphatic drainage from the mental region, apex of the tongue, lower lip, and incisor teeth. Also, small veins anastomose in this triangle to form the anterior jugular vein [16]. As the anterior belly of the digastric muscle can present with variable anatomy or even be absent, the submental triangle can be distorted or absent. When odontogenic infections from the lower central and lateral incisors progress to the labial aspect of the alveolar processes of the mandible and break through the bone under the attachment of the mentalis muscle, they usually appear as an abscess or fistula on the skin in the chin area. Occasionally, they can spread out into the submental space and form an abscess [19]. The swelling occurs around the chin and the submental triangle, occasionally extraoral incisions are necessary to treat such abscesses and the risk of the incision is low because structures within the triangle are sparse and include no arteries.

### Posterior Triangle of the Neck

The posterior cervical triangle is bounded by the posterior border of the SCM anteriorly, the anterior border of the trapezius muscle posteriorly, and middle one-third of the clavicle inferiorly. Its floor is covered with the prevertebral layer of the deep cervical fascia. The posterior cervical triangle is subdivided into occipital and supraclavicular (subclavian or omoclavicular) triangles by the omohyoid muscle. It contains the accessory lymph nodes, the inferior deep lymph nodes, the transverse cervical lymph nodes, the suprascapular artery, the subclavian artery, the external jugular vein (EJV), the accessory nerve, great auricular nerve, transverse cervical nerve,

supraclavicular nerve, the inferior belly of the omohyoid, and branches of the thyrocervical trunk [16]. It also includes branches to the levator scapulae, serratus anterior and rhomboid muscles.

Vagus nerve stimulation is an effective treatment for intractable epilepsy [20]. This treatment generally exposes the vagus nerve in the neck using an anterior approach medial to the SCM. Anatomical structures that can be injured during an anterior approach to expose the cervical part of the vagus nerve are the common facial vein, IJV, superior and middle thyroid veins, accessory nerve, transverse cervical nerve, hypoglossal nerve, C1 and C2 spinal nerve roots, and ansa cervicalis. Tubbs et al. reported a potentially useful approach to the vagus nerve through the posterior cervical triangle [21]. This approach did not injure any of the structures during the posterior approach to the vagus nerve in the neck and might be used for vagus nerve stimulation procedures for treating epilepsy. Moreover, it is necessary to avoid injury to the accessory nerve, which enters the SCM from behind approximately 5 cm inferior to the tip of the mastoid process and emerges between the superficial and prevertebral layers of the deep cervical fascia [22-24].

### ***Occipital triangle***

The occipital triangle is located in the superior part of the posterior cervical triangle. The anterior and posterior borders of this triangle are the same as those of the posterior cervical triangle, but the inferior border is the inferior belly of the omohyoid. Its floor consists of the levator scapulae, splenius capitis, and middle and posterior scalene muscles. The semi-spinalis capitis muscle is sometimes observed at the apex as well as occipital lymph nodes. The triangle is bounded by the superficial and deep layers of the deep cervical fascia. The accessory nerve runs on the surface of the levator scapulae muscle obliquely downward and reaches the deep surface of the trapezius muscle. Cutaneous and muscular branches of the cervical plexus appear from the posterior edge of the SCM. The supraclavicular nerves, the transverse cervical artery, and part of the brachial plexus can be found in the triangle. Accessory lymph nodes and inferior deep lateral cervical lymph nodes exist along with the posterior border of the SCM.

### ***Supraclavicular triangle***

The supraclavicular triangle is a clinically important anatomical area. Diseases of the vessels and lymph nodes located in it cause various clinical syndromes. This triangle is the an-

terior division of the posterior cervical triangle. The anterior and inferior borders are the same as those of the posterior cervical triangle, but the superior border is the inferior belly of the omohyoid. It corresponds to the supraclavicular fossa, which is immediately above the clavicle. Its size depends on the degree of clavicular attachments of the SCM and trapezius muscle, and the location of the inferior belly of the omohyoid muscle. It is bounded by the superficial and deep fasciae and the platysma muscle, and the supraclavicular nerves travel across it. It mainly contains the subclavian artery and vein, and the brachial plexus. The trunks of the brachial plexus and the subclavian artery can be palpated with an examining finger. The suprascapular vessels and dorsal scapular artery run transversely across the triangle. The EJV runs behind the posterior border of the SCM to end in the subclavian vein. The phrenic nerve exists on the anterior surface of the anterior scalene muscle. This triangle may also harbor the accessory phrenic nerve (APN), which is a common anatomical variant that most often arises from the ansa cervicalis followed by the C5/C6 ventral rami [25]. The APN commonly lies lateral to the phrenic nerve and travels posterior and occasionally anterior to the subclavian vein [16, 26]. It frequently communicates with the phrenic nerve in the thorax, and forms a loop below the subclavian vein or the internal thoracic artery [27]. Therefore, APN injury can occur with surgical procedures in this region, e.g., scalenectomy [28, 29]. The triangle also contains inferior deep cervical lymph nodes, which drain the inferior larynx, thyroid gland, trachea, and back of the scalp [30]. The left supraclavicular lymph nodes are sometimes called “Virchow’s node,” “Troisier’s node,” and “the node of Virchow-Troisier” and represent sentinel lymph nodes when sufficiently enlarged [31-33]. Diseases of the scalp, neck, pectoral, and brachial areas and adenopathy due to lesions from the mediastinum, diaphragm, parotid, breast, and SCM areas can occur in the subclavian triangle [34]. Moreover, tumor metastases, especially of the lung, breast, stomach, and esophagus can occur in it. In malignant disease in the viscera, e.g., the stomach, the pancreas, the ovaries, the metastasis ascends from the lymph nodes of the lower abdomen to the lymph nodes in the posterior mediastinum along the thoracic duct and finally reaches to the supraclavicular lymph nodes around the drainage of the thoracic duct into the junction of the left internal jugular and left subclavian veins in the left supraclavicular fossa [31].

## Suboccipital Triangle

The suboccipital triangle is bounded by the obliquus capitis superior, the obliquus capitis inferior, and the rectus capitis posterior major muscles [35]. Its floor is made up of the posterior arch of the atlas and the posterior atlanto-occipital membrane. It contains the V3 segment of the vertebral artery, vertebral venous plexus, and the suboccipital nerve. The greater occipital nerve curves under its base as it ascends onto the occiput. Loukas and Tubbs [36] found an accessory muscle within it, which can potentially compress the vertebral artery. As the origin of pain is often muscular according to the medical literature, so it is possible that such an accessory muscle could result in pain [37]. Ossification of the posterior atlanto-occipital membrane in the floor of this triangle can compress the vertebral artery resulting in ischemic symptoms.

## Triangle of the Vertebral Artery

This triangle is located at the deep layer of the root of the neck and contains important neurovascular structures, e.g., vertebral artery and nerve, C8 ventral ramus. Moreover, this triangle potentially includes the inferior thyroid artery, C7 ventral ramus, phrenic nerve, middle and inferior cervical ganglion, vertebral ganglion, and cervicothoracic (stellate) ganglion [38]. The boundaries of the triangle of the vertebral artery are the medial border of the anterior scalene muscle, the lateral border of the longus cervicis muscle, and the first part of the subclavian artery (Fig. 5) [38-40]. The apex of this triangle is the anterior tubercle of the transverse process of the C6 vertebra (carotid tubercle or Chassaignac's tubercle), the posterior wall of this triangle includes the prevertebral fascia and the part of the middle scalene muscle [38]. The vertebral artery travels superiorly within this triangle after branching from the subclavian artery at the level of T1 vertebra and transverse the transverse foramen of the C6 vertebra in most cases [38, 41-43]. When vertebral-basilar insufficiency is induced by osteophytic compression of the vertebral artery in the C6 transverse foramen, a foraminotomy may be performed [44]. Iatrogenic injury by this procedure can result in Horner's syndrome because the middle cervical ganglion is sometimes located near the C6 transverse foramen [38].

## Scalene Triangle

The boundaries of the scalene triangle are as follow; medi-

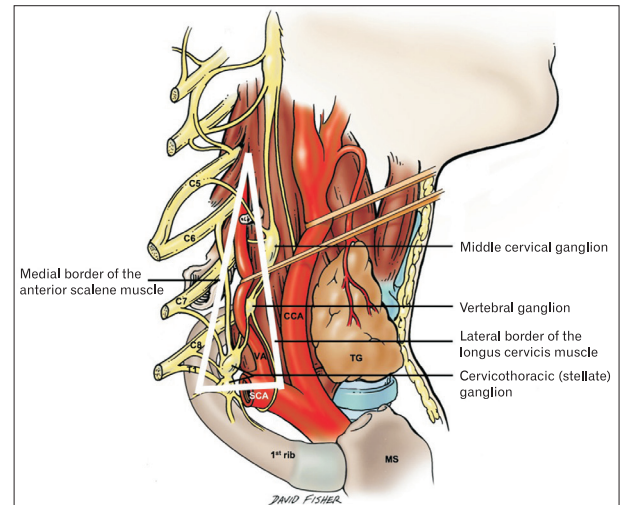


Fig. 5. Schematic drawing of the triangle of the vertebral artery on the right lateral neck region (white solid line). CCA, common carotid artery; MS, manubrium of the sternum; SCA, subclavian artery; TG, thyroid gland; VA, vertebral artery.

ally the lateral border of the anterior scalene, laterally the medial border of the middle scalene, and inferiorly the first rib. It contains important structures, i.e., the brachial plexus and the third part of the subclavian artery. The potential space of this triangle may depend on the attachment, variations, and hypertrophy of the scalene muscles [45]. Also, the scalenus minimus muscle, which exists relatively frequently, may affect its space [46]. Anatomical variations of the scalene muscles can cause compression of neurovascular structures at the thoracic outlet and lead to thoracic outlet syndrome. Anatomically, three areas are considered that cause the thoracic outlet syndrome; the costoclavicular space, the scalene triangle, and the pectoralis minor space [47]. The scalene triangle is located in the most superior of these areas. In this area, the presence of the scalenus minimus muscle, fusion of the anterior and middle scalene muscles, a fracture of the first rib, anatomical anomalies such as a cervical rib and a fused cervical and first rib or fused first and second rib can induce thoracic outlet syndrome with pressure on the subclavian vessels and brachial plexus [48].

## Conclusion

Anatomical landmarks can be useful during surgery of the neck. There are many triangles in the neck containing arteries, veins, nerves, lymph vessels and nodes, and other important structures. A better understanding of the anatomy

of these triangles of the neck could help to minimize surgical injuries and make surgical dissections more efficient.

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