In the ventrolateral region of the neck, the muscles are arranged in three strata: the subcutaneous, superficial and deep brachiocephalic layers. These three layers are derived through the stratification of a single primitive muscle sheet, which can still be found in some lower vertebrates, and retains direct continuity with the abdominal part of the ventral muscle. The sternothyroid (ST) muscle is a part of the deep brachiocephalic layer and lies deep to as well as medial to the sternothyroid muscle; it originates from the posterior surface of the manubrium sterni and the posterior margin of the first costal cartilage, passing into the oblique line of the thyroid cartilage. The ST muscle may be in two layers or many fascicles; among them, the lateral layer may end in the fascia colli. A levator glandulae thyroideae (LGT) fibrous or fibromuscular band may descend from the inferior margin of the hyoid bone to the lobes, isthmus or pyramidal lobe of the thyroid gland. A LGT muscle may be present alongside variations of the infrahyoid muscles.

Clinical Significance of an Unusual Variation
Anomalous additional belly of the sternothyroid muscle

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Abstract: The infrahyoid muscles are involved in vocalisation and swallowing; among these, the sternothyroid muscle is derived from the common primitive sheet. The improper differentiation of this muscle may therefore result in morphological variations. We report an unusual variation found during the dissection of a 65-year-old male cadaver at the Sri Manakula Vinayagar Medical College, Madagadipet, Pondicherry, India, in 2015. An anomalous belly of the right sternothyroid muscle was observed between the internal jugular (IJ) vein and the internal carotid artery with an additional insertion into the tympanic plate and petrous part of the temporal bone and the presence of a levator glandulae thyroideae muscle. The anomalous muscle may compress the IJ vein if it is related to the neurovascular structures of the neck; hence, knowledge of variations of the infrahyoid muscles can aid in the evaluation of IJ vein compression among patients with idiopathic symptoms resulting from venous congestion.

Keywords: Neck Muscles; Thyroid Gland; Cervical Plexus; Jugular Veins; Case Report; India.

In the ventrolateral region of the neck, the muscles are arranged in three strata: the subcutaneous, superficial and deep brachiocephalic layers. These three layers are derived through the stratification of a single primitive muscle sheet, which can still be found in some lower vertebrates, and retains direct continuity with the abdominal part of the ventral muscle. The sternothyroid (ST) muscle is a part of the deep brachiocephalic layer and lies deep to as well as medial to the sternothyroid muscle; it originates from the posterior surface of the manubrium sterni and the posterior margin of the first costal cartilage, passing into the oblique line of the thyroid cartilage. The ST muscle may be in two layers or many fascicles; among them, the lateral layer may end in the fascia colli. A levator glandulae thyroideae (LGT) fibrous or fibromuscular band may descend from the inferior margin of the hyoid bone to the lobes, isthmus or pyramidal lobe of the thyroid gland. A LGT muscle may be present alongside variations of the infrahyoid muscles.

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Case Report

A regular anatomy dissection session of a 65-year-old male cadaver was performed at the Sri Manakula Vinayagar Medical College, Madagadipet, Pondicherry, India, in 2015. During this dissection, an anomalous right ST muscle was found. The muscle originated from the posterior surface of the manubrium sterni at the medial end of the costal cartilage of the first rib. It divided into a medial and a lateral slip approximately 2.7 cm distal to its origin. The medial slip was inserted superiorly to the oblique line of the thyroid cartilage; however, the lateral slip ascended and some of its fibres were attached to the fascial sheath of the great vessels of the neck, also known as the carotid sheath [Figure 1]. The muscle terminated between the internal jugular (IJ) vein and internal carotid (IC) artery as well as the emerging glossopharyngeal and hypoglossal nerves [Figure 2]. It was attached to the lower sharp edge of the tympanic plate of the temporal bone and also to the bony ridge.
Anomalous additional belly of the sternothyroid muscle

An LGT muscle was also found on the same side, arising from the hyoid bone and passing into the false capsule on the anterior margin of the right lobe of the thyroid gland. Since the anomalous lateral belly of the ST muscle was between the great vessels of the neck, this could have caused compression of the IJ vein and potentially resulted in venous stasis of its formative tributary, the sigmoid sinus. The cranial cavity was therefore opened to examine the variation in the size of the sigmoid sulcus on the right side. An osseous bridge was observed over the right sigmoid sulcus in the posterior cranial fossa connecting the angulation of the anterior lip with the posterior lip. The sigmoid sulcus of the sinus was significantly larger and deeper on the right side of the posterior cranial fossa [Figure 3].

Discussion

Pre-muscle tissue (approximately 7 mm in length) appears in the cervical region of very young embryos as a result of mesenchymal condensation and with the contribution of myoblasts of the cervical hypomere (e.g. the hypaxial mesoderm). The TBX1 gene regulates the myogenic differentiation and cellular fate within the mesoderm. This gene codes for the T-box protein and is found on the q arm of chromosome 22 at position 11.21. Inactivation or deletion of this gene can lead to serious alterations in the morphology of neck muscles. Mesenchymal condensation later develops into a distinct band of infrahyoid pre-muscle tissue extending to either side, from the base of the tongue caudolaterally towards the tip of the first rib. Cleavage of this tissue thus forms the most ventral muscles of the neck which are supplied by the ramus of the descendens hypoglossi. Initially, the infrahyoid pre-muscle band divides into deep and superficial layers, after which the superficial sheath then divides into inner and outer muscles; the inner muscle eventually forms the sternothyroid muscle and the...
lower part of the outer muscle forms the omohyoid muscle. The deep stratum of the undifferentiated muscle mass becomes the ST and thyrohyoid muscles. Since the pre-muscle mass extends from the base of the tongue to the tip of first rib, improper cleavage and differentiation may lead to variations of the derivative muscles.

To the best of the authors’ knowledge, the variation of the ST muscle observed in the present case is unique and has not been previously reported. Among 36 cadavers with muscular variations reported in previous research, one had a duplicate ST muscle with the additional slip arising from the first costal cartilage and the costoclavicular ligament, joining the normal one halfway up the neck. In an earlier similar observation by the same author, the abnormal slip (known as the costo-fascialis cervicalis) terminated in the cervical fascia under the sternocleidomastoid muscle. Humphry reported that the ST muscle can be double, either wholly, partially or divided into two lateral portions running parallel with one another. However, in the present case, the lateral belly was attached to the carotid sheath as well as to the bony ridge between the jugular fossa and the lower opening of the carotid canal.

In the present case, the cranial half of the anomalous lateral belly of the ST muscle passed between the IJ vein and the IC artery for a short distance before its insertion. These neurovascular links are of great clinical value; other reports have indicated that variations of the omohyoid muscle resulted in compression of the IJ vein, which could in turn hinder venous return from the head and neck. In addition, the IJ vein can be compressed by other abnormal neck muscles, including variations of the ST muscle. Compression of the IJ vein may lead to IJ vein thrombosis and cause an embolism in the pulmonary artery. In the current case, the anomalous lateral belly of the ST muscle may have compressed the IJ vein and caused thrombosis; however, this cannot be known for sure. In addition, the anomalous belly of the ST muscle lay between the glossopharyngeal and hypoglossal nerves near its termination. This may have compressed the nerves related to this region, potentially resulting in unilateral palsy. As such, it is possible that the cadaver suffered from Collet-Sicard syndrome; this condition involves the IX to XII cranial nerves and can be caused by idiopathic IJ vein thrombosis.

Sigmoïd sinus enlargement can cause pulsatile tinnitus. In the current case, the ST of the right sigmoïd sinus was significantly enlarged, perhaps due to the compression of the IJ vein by the anomalous lateral belly on the right side. The usual course of the sigmoïd Muscle is vertical on the mastoid section of the temporal bone, followed by anteromedial in the jugular process of the occipital bone and terminating at the jugular foramen. The anterior margin of the sigmoïd Muscle is more prominent than the posterior margin. Moreover, the anterior lip has three parts: lateral, junctional (with angulation) and medial; the first section is formed by the mastoid part of the temporal bone, whereas the other two are formed by the jugular process of the occipital bone. In the present case, an osseous bridge over the right sigmoïd Muscle connected the angulation of the anterior lip with the posterior lip of the sigmoïd Muscle. The presence of an osseous bridge over the terminal part of the right sigmoïd sinus may be due to the ossification of a thickened dura mater at the angulation. In the authors’ opinion, this bridge could compress the sigmoïd sinus and cause fatal thrombosis of the sigmoïd sinus or IJ vein. Thrombosis of the sigmoïd sinus or sigmoïd jugular complex would block the drainage of the cerebral veins into the IJ vein; this could raise the intracranial pressure, which might subsequently cause epileptic seizures. Thus, in cases of epileptic seizures of unknown aetiology, IJ vein compression by an additional belly of the ST muscle should be considered.

The presence of a LGT muscle along with a variation of the ST muscle might be due to the improper stratification of the embryological primordial muscle sheet. Since the LGT muscle and other infrahyoid muscles are derived from a common source, any variation in the infrahyoid muscle group may accompany the occurrence of the LGT muscle. Kim et al. reported a rare finding of a duplicated omohyoid muscle with the occurrence of a LGT Variation of the ST muscle observed in the present case is unique and has not been previously reported. Among 36 cadavers with muscular variations reported in previous research, one had a duplicate ST muscle with the additional slip arising from the first costal cartilage and the costoclavicular ligament, joining the normal one halfway up the neck. In an earlier similar observation by the same author, the abnormal slip (known as the costo-fascialis cervicalis) terminated in the cervical fascia under the sternocleidomastoid muscle. Humphry reported that the ST muscle can be double, either wholly, partially or divided into two lateral portions running parallel with one another. However, in the present case, the lateral belly was attached to the carotid sheath as well as to the bony ridge between the jugular fossa and the lower opening of the carotid canal.

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References:
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Anomalous additional belly of the sternothyroid muscle, as described by Kim et al.,
5. Kim DI, Kim HJ, Park JY, Lee KS. Variation of the infrahyoid muscle sheet; this theory is supported by the presence of the glossopharyngeal and hypoglossal nerves near its insertion. A unique variation was noted in a cadaver involving the sternothyroid muscle; the LGT muscle is under debate. Lehr opined that this muscle might be a derivative of the cricothyroid muscle. Eisler et al. also theorised that this muscle might be derived from the cricothyroid, thyrohyoid and inferior constrictor muscles of the pharynx. Kim et al. suggested that the development of a LGT muscle is genetic and may be similar to the development of the omohyoid muscle.5

Conclusion
A unique variation was noted in a cadaver involving the insertion of an anomalous lateral belly of the ST muscle which passed between the IJ vein and IC artery for a short distance before insertion and lay between the glossohypharyngeal and hypoglossal nerves near its termination. Infrahidoid muscles may show variations due to the improper stratification of the primordial muscle sheet; this theory is supported by the presence of a LGT muscle along with an anomalous lateral belly, as seen in this case. Knowledge of possible variations of the infrathyroid muscles is necessary in order to avoid iatrogenic trauma during surgery as well as to evaluate compression of the IJ vein in cases of idiopathic seizures.

References