Surg Radiol Anat (2013) 35:969–972
DOI 10.1007/s00276-013-1111-7

ANATOMIC VARIATIONS

Thoracic duct relationships to abnormal neurovascular structures in cervicothoracic regions: case study and clinical relevance

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Received: 26 October 2012 / Accepted: 19 March 2013 / Published online: 28 March 2013
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Abstract The presence of variant intercostal and bronchial arteries and variable position of left recurrent laryngeal nerve (LRLN) along the course of thoracic duct (TD) may have clinical relevance in various cervicothoracic surgeries.

Keywords Thoracic duct · Anomalous bronchial artery · Innervation

Introduction

The presence of variant blood vessels or nerves in close relationship to the TD may have clinical relevance to TD injury in various mediastinal and cervical surgeries.

Case study

The TD was traced from its origin until termination in old female during the dissection of 25 cadavers at anatomy department, Osaka medical college. After passing through the aortic hiatus, the TD ascended normally behind the esophagus between descending aorta and azygos vein until the level of tracheal bifurcation (T4–5) where it became paraesophageal (Fig. 1, inset). The duct passed upward through a vascular tunnel formed by anomalous bifurcated right posterior intercostals artery (Fig. 1, inset), then passed deep to the aortic arch. Sectioning and retraction of aortic arch ventrally revealed that the TD passed deep to variant common bronchial artery trunk arising from the aortic arch at its junction with descending aorta. At this location, the LRLN looped under the aortic arch superficial to both the TD and the variant common bronchial artery trunk (Fig. 1). Thus, the common bronchial artery trunk near its origin was between LRLN ventrally and TD dorsally. The bronchial artery crossed the left main bronchus ventrally toward the carina where it terminated at the right main bronchus after giving branches to both bronchi. The TD was followed cranially to the superior mediastinum and root of the neck (Fig. 2 and left inset). The TD ascended deep to the left subclavian artery then reappeared between the latter artery and the esophagus close to and just deep to LRLN within a vascular cervical triangle formed by left subclavian, left common carotid and inferior thyroid arteries. The TD then arched crossing ventral to the sympathetic trunk and left subclavian artery below the inferior thyroid artery where it received a branch from the middle cervical ganglion (Fig. 2), right lower inset). In addition, the latter ganglion sent a nerve loop; ansa subclavia just above the dome part of TD. The duct finally descended down crossing the vertebral vein superficially to its termination at the venous angle.

Discussion

Normally and during ascent of the TD through the posterior mediastinum, the thoracic vertebrae, right intercostal arteries, and terminal portions of the hemiazygos and accessory hemiazygos veins are posterior to it [12]. At the level of T5, the TD enters the superior mediastinum where it is first crossed anteriorly by the aortic arch and then runs posterior to the initial segment of the left subclavian artery.

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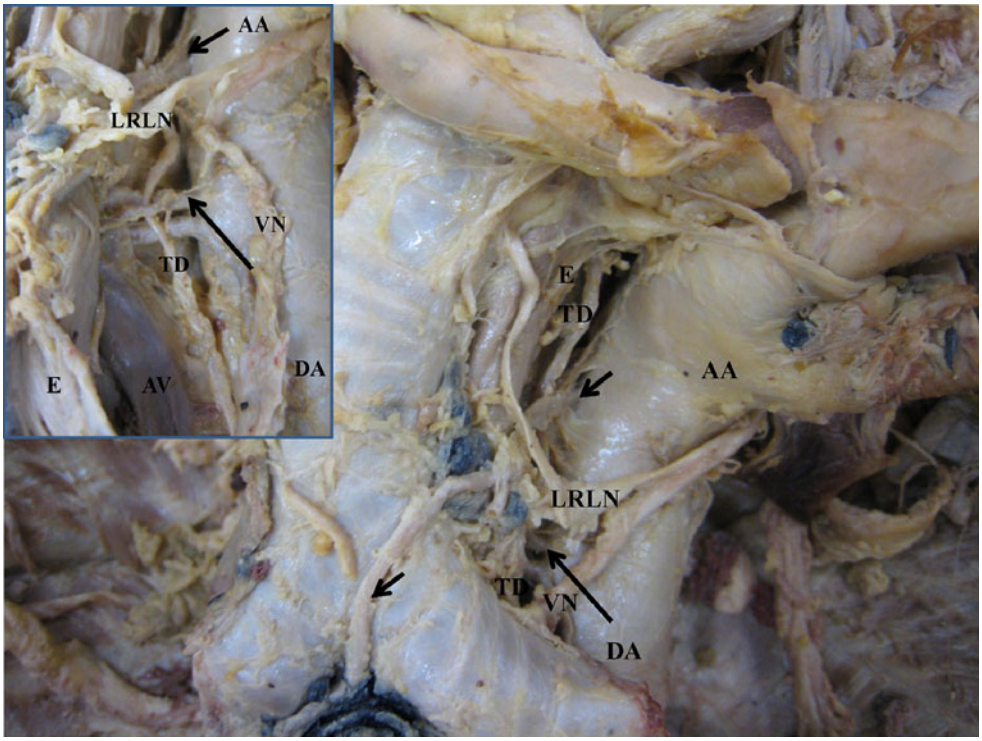

Fig. 1 Dissection of mediastinal portion of thoracic duct (TD). The aortic arch (AA) was sectioned and displaced laterally. The *inset* shows a deeper dissection of the TD by retraction of esophagus anteriorly. The *long arrows* indicate anomalous intercostals artery while the *short arrows* mark anomalous common bronchial artery trunk. *E* esophagus, *LRLN* left recurrent laryngeal nerve, *AV* azygos vein, *VN* vagus nerve

Passing into the neck, it arches laterally at the level of the C7, and curves anterior to the vertebral vessels, the left sympathetic trunk and the thyrocervical trunk or its branches. Finally, the duct descends anterior to the left subclavian artery and ends by opening into the junction of the left subclavian and internal jugular veins [14]. In the present case, the passage of TD within a vascular tunnel formed by bifurcated intercostal artery (Fig. 1, inset) may result in its injury during exposing intercostal arteries in surgical treatment of descending thoracic aneurysms [7]. Also at this location, the duct could be injured during thoracoscopic approaches for sympathectomy, discectomy and corpectomy [1, 4]. After its exit from the vascular intercostal tunnel, the duct passed just deep to variant common bronchial artery trunk (Fig. 2). The presence of variant common bronchial artery trunk was previously reported where it looped under LRLN [3]; however, in this case, the artery is found between the TD dorsally and LRLN ventrally. Therefore, there is a possibility of injury of both LRLN and TD during ligation or selective embolization of this artery for the treatment of recurrent hemoptysis and bronchial arteriovenous malformations [2, 10, 16].

As shown in Fig. 2, the TD entered the neck where it arched laterally passing superficial to left subclavian artery and deep to Left common carotid artery where it formed the dome part (Fig. 2). This cervical part of TD usually passes anterior to the thyrocervical trunk or its branches [14]. However, as shown in Fig. 2, the cervical part of TD passed below the inferior thyroid artery in a relatively lower position than usual. This relatively lower position of TD may render it more liable to be injured in stellate ganglion blocking [15]. TD injury during anterior cervical discectomy was the result of unusually cephalic location of the TD arch in the neck [4]. Moreover, the arched part of TD received a direct branch from middle cervical ganglion close to ansa subclavia (Fig. 2 and right lower inset). Whether it is innervation of or just abnormal communication to the TD from middle cervical ganglion, this needs further studies. This is supported by recent study in young and elderly human subjects where immunostaining for general nerve fibers with a PGP 9.5 marker disclosed a diffuse innervation of the TD in young subjects, which was strongly reduced in elderly subjects The authors found that, in young subjects, tyrosine hydroxylase and neuropeptide Y immunoreactive fibers, markers of noradrenergic postganglionic sympathetic fibers were frequent [6]. It is possible that such innervation of TD by middle cervical ganglion acts in a similar way to the innervation of the aortic body by same ganglion through ansa subclavia [5]. In addition, it has been reported that the stellate ganglion gives off a cardiac

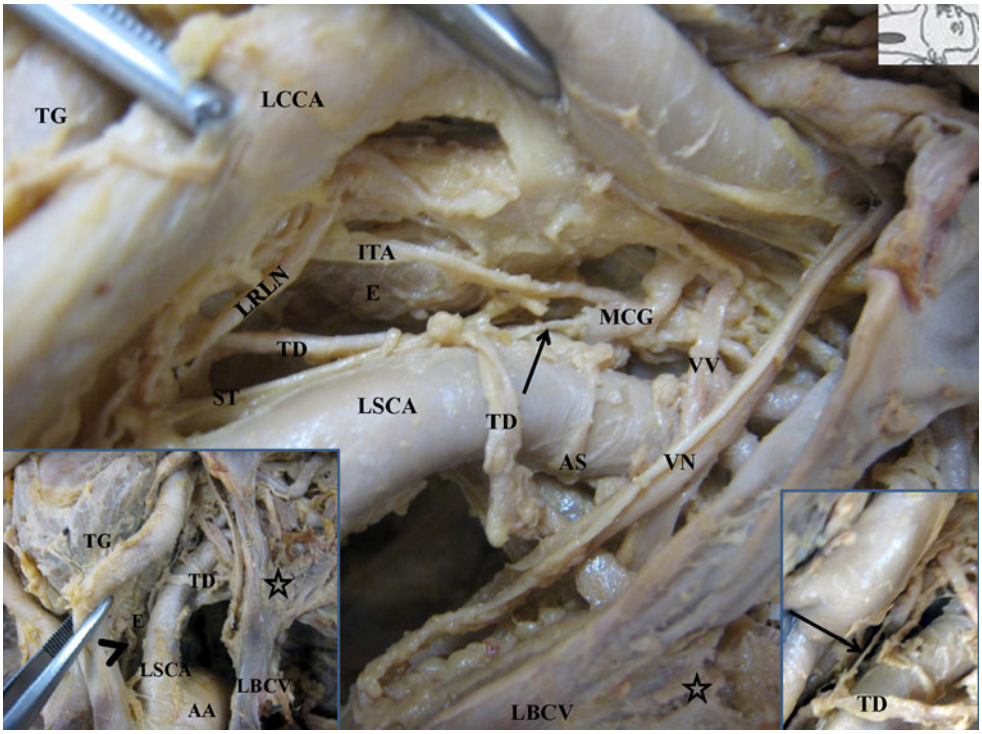

Fig. 2 Dissection of cervical portion of TD. *AA* aortic arch, *LSCA* left subclavian artery, *LCCA* left common carotid artery, *TD* thoracic duct, *LRLN* left recurrent laryngeal nerve, *E* esophagus, *ITA* inferior thyroid artery, *TG* thyroid gland, *ST* sympathetic trunk, *AS* ansa subclavia, *VV* vertebral vein, *LBCV* left brachiocephalic vein. The *long arrows* in the main figure and *right lower inset* point to a branch from middle cervical ganglion (MCG) to TD while *arrow head in left lower inset* indicates LRLN. The *star* marks the left venous angle

branch and branches to nearby vessels [14]. Figure 2 showed that both the cervical vertical (ascending) part of TD and LRLN are located close to each other within a triangle bounded by left subclavian artery laterally, left common carotid artery medially and inferior thyroid artery superiorly (this triangle is formed artificially by widening the interval between left common carotid and left subclavian arteries). This arterial triangle has some similarity to Simon triangle which is formed by the esophagus medially, carotid artery laterally and inferior thyroid artery superiorly regarding the presence of LRLN within the contents of both triangles [9, 13]. Many surgeons prefer to identify the LRLN below the inferior thyroid artery level and trace its course to the nerve junction during thyroidectomy [8]. However, as shown here in Fig. 2, the TD is below the inferior thyroid artery and close to abnormally located LRLN (near lateral border of esophagus); therefore, the duct may be injured in this location when surgeons try to identify LRLN in thyroidectomy and central neck dissection for malignant tumors [11].

In summary, the presence of abnormal intercostal and bronchial arteries and variable position of LRLN along the course of TD should be expected by surgeons to avoid iatrogenic damage to the TD and/or related abnormal neurovascular structures in various surgeries, which could be fatal.

Conflict of interest The authors declare that they have no conflict of interest. No financial relationship with any organization regarding this work is found.

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