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Anatomical variation of thyroid veins on contrast-enhanced multi-detector row computed tomography

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ABSTRACT

Objective: The objective of this study was to clarify the anatomical variation of thyroid veins into the systemic vein using contrast-enhanced multi-detector row computed tomography (MDCT).
Design and methods: : The subjects were 80 patients (34 males and 46 females; mean age, 50.1 years; age range, 15–92 years) with neck diseases who underwent MDCT. The number and location of inflow points of the thyroid veins into the systemic vein, and the length from the junction of bilateral brachiocephalic veins to the orifice of inferior thyroid vein were investigated by reviewing the axial and coronal images.
Results: All superior thyroid veins were detected. Right and left middle thyroid veins were identified in 39 and 29 patients, respectively. Right inferior thyroid veins, left inferior thyroid veins, and common trunks were detected in 43, 46, and 39 patients, respectively; in five patients, two left thyroid veins were identified. All left inferior thyroid veins and 34 common trunks flowed into the innominate vein, while right ones had some variations in inflow sites. Mean lengths were 3.01 ± 1.30 cm (range, 0.5–6.19) and 2.04 ± 0.91 cm (0.5–4.4) in the left inferior thyroid vein and common trunk, and 1.96 ± 1.05 cm (0.81–4.8) and 1.65 ± 0.69 cm (0.63–2.94) in the right one flowing into the right internal jugular vein and the innominate vein, respectively.
Conclusions: The numbers and orifices of thyroid veins were identified at high rates on contrast-enhanced MDCT. This strategy can provide anatomical information before selective venous sampling for measurements of parathyroid hormone.

1. Introduction

Hyperparathyroidism (HPT) is a disorder of excess parathyroid hormone that results in elevations in serum and urine calcium. Patients who are symptomatic or who fulfil the diagnostic criteria of the National Institutes of Health consensus panel require surgery, such as parathyroidectomy [1]. To improve surgical outcome and reduce complications, it is important to identify the location of the abnormal gland via preoperative procedures, such as ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI), 99m-Tc sestamibi scintigraphy, and selective venous sampling (SVS) for measurement of parathyroid hormone levels [2,3]. The combination of 99m-Tc sestamibi scintigraphy and US of the neck have a sensitivity of 90% for the localization of the abnormal gland and are the most widely used noninvasive localization studies [4]. However, these modalities are still inferior to SVS in localizing the abnormal gland [3,5,6].

Knowledge of the anatomy of the thyroid veins is important for successful SVS. The thyroid veins consist of three branches on each side (superior, middle, and inferior) that communicate with one another. Previous studies have characterized complex anatomical variations of the thyroid veins in cadavers and via venography [7,8]. However, no study has identified the drainage variations of the thyroid veins by multi-detector row CT (MDCT). Knowledge of the sites of thyroid vein inflow points prior to the procedure is necessary to reduce both examination time and the difficulty of catheterization. This is especially true for the inferior thyroid veins, because the inferior parathyroid gland is a common site of HPT and because the inferior thyroid veins reflect changes in parathyroid hormone gradient to a greater degree than do the superior and middle thyroid veins [9,10]. When the catheter does not advance into the inferior thyroid veins selectively in the venous sampling,

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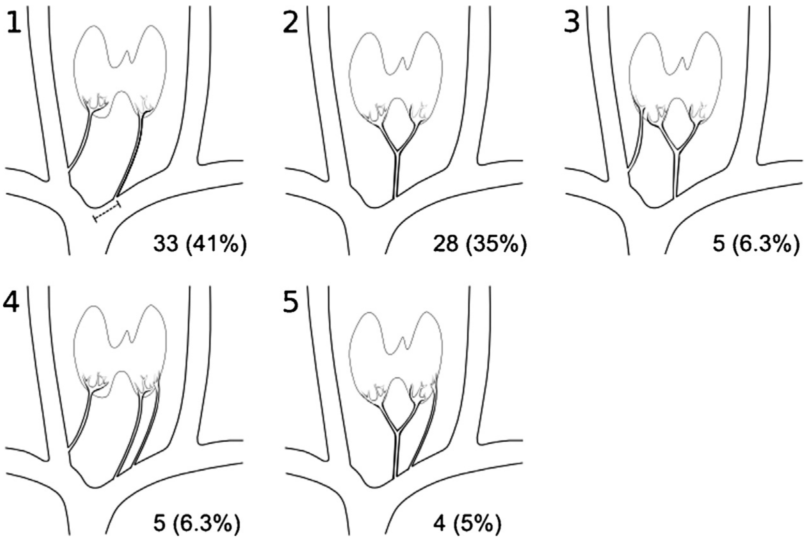

Fig. 1. Examples of combinations of inferior thyroid veins. An example of measurement of the length from the junction of both brachiocephalic veins to the orifice of the left inferior thyroid vein is shown in A.1 (dotted line). A right inferior vein and a left inferior vein (1), a common trunk (2), a right inferior vein and a common trunk (3), a right inferior vein and two left inferior veins (4), and a left inferior vein and a common trunk (5) are shown. Numbers on the lower right are the number and percentage of the subjects.

this information would help us to know hormone level changes between the proximal and distal sites of the inflow points of inferior thyroid veins.

Therefore, the aim of this study was to characterize the anatomical variations of thyroid veins into the systemic vein via contrast-enhanced MDCT.

2. Design and methods

2.1. Subjects

We reviewed the records of 87 patients who gave informed consent to undergo contrast-enhanced CT (CECT) from the skull base to the aortic arch from March 2012 to March 2014. This retrospective study was approved by our institutional review board. The subjects underwent CT examination to evaluate pharyngeal carcinoma, malignant lymphoma, parotid gland tumor, cervical cyst, cervical abscess, acute epiglottitis, HPT, and enlarged lymph node and recurrent nerve paralysis. The patient who received the radiotherapy was not included in this study. After CT scans were reviewed, patients were excluded from this study if they had thyroid tumor ($n = 2$), a past history of operation for neck disease ($n = 3$), or poor CT image quality due to artifacts from the shoulder ($n = 2$). Thus, 80 subjects (34 males and 46 females; mean age, 50.1 years; age range, 15–92 years) were included in this study.

2.2. CT scanning technique

All CECT images from the skull base to the lower edge of the aortic arch were obtained on a 64-row MDCT (Aquillion; Toshiba Medical System, Tokyo, Japan). The amount of contrast material was 2 mL/kg (300 mg I/mL), which was injected at 1.5 mL/s. At 90 s after initiation of the injection, the CT images were obtained using the following parameters: collimation, 64×0.5 mm; tube voltage, 120 kVp; reference tube current, 200 mA; gantry rotation time, 0.5 s; beam pitch, 0.844 (helical pitch, 27); CT dose index volume, 24.8 mGy; dose length product, 762.4 mGy cm. The imaging field of view (FOV) was 180×180 mm^2, and the pixel size was 0.35×0.35 mm^2. The scan data were reconstructed to axial images with a slice thickness of 1 and 3 mm at the time of examination. The coronal images were reconstructed from 1 mm-thick axial images with a slice thickness of 2 mm without overlapping of section intervals. However, only the 3 mm-thick axial and coronal images were stored in our PACS and they were available for the retrospective analysis.

2.3. Measurement and analysis of the thyroid veins

The superior thyroid vein was identified as a vessel arising from the superior pole of the thyroid gland and flowing into the internal jugular vein or veins superior to the internal jugular vein. The middle thyroid vein was identified as a horizontal running vessel draining into the internal jugular vein from the lateral surface of the thyroid gland. The inferior thyroid vein was identified as a vessel arising from the inferior pole of the thyroid gland and draining into a brachiocephalic vein or internal jugular vein. The common trunk was defined as a vessel joining the right and left inferior thyroid veins (Fig. 1). Thyroid veins were identified independently by two radiologists (T.Y. and H.T.) who had 24 and 2 years of experience, respectively. In cases of independent disagreement between the radiologists, interobserver agreement was reached by consensus.

The number and type of thyroid veins was recorded, and the site of inflow points of the inferior thyroid veins was characterized. The length from the junction of the bilateral brachiocephalic veins to the inflow points of the inferior thyroid veins was measured. The length was the straight-line distance on coronal images (Fig. 1A), which was projected from the junction of the bilateral brachiocephalic veins into the orifice in an anteroposterior direction to simulate fluoroscopic observation on SVS.

3. Results

Bilateral superior thyroid veins were visualized via CECT in all 80 patients. All superior thyroid veins flowed into the internal jugular vein, facial vein, or lingual vein. Forty veins among 39 patients were identified as the right middle thyroid vein, while 30 veins among 29 patients were identified as the left middle thyroid vein.

The number of inferior thyroid veins is shown in Table 1. Forty-four right inferior thyroid veins were identified among 43 patients. Fifty-one left inferior thyroid veins were identified among 46 patients, in whom five patients had two veins each. There were 39 common trunks among 39 patients. At least one of these veins