Abstract

Background: The position and size of isthmus of thyroid gland varies considerably in human with age, sex, physiologic state, race and geographical location and sometimes the isthmus may be absent. So this study was designed to find out the macroscopic differences in isthmus of thyroid gland of different age and sex groups in Bangladeshi people. Objective: To record the macroscopic characteristics of isthmus of thyroid gland with advancing age in both sexes with a view to help establishing normal standard of Bangladeshi people. Materials and Methods: This descriptive cross-sectional study was carried out on 54 autopsied human thyroid glands aged 5 to 65 years. Thyroid glands were collected from unclaimed dead bodies autopsied in the morgue of Sylhet M. A. G. Osmani Medical College, Sylhet. The collected specimens were divided into groups — A (20 years and below), B (21 to 50 years) and C (50 years and above). All specimens were examined morphologically by careful gross dissection method. Results: The isthmus was absent in 5.56% cases. In most of the cases (35.29%) it was against the 1st–4th tracheal rings. There was significant difference in length between Group A and Group C (p<0.05) and in breadth between Group A and Group C and between Group B and Group C (p<0.05). No significant difference was found in length, breadth and thickness of isthmus of the thyroid gland between males and females. Conclusion: The presence or absence, positional change and variation in gross dimension of isthmus of thyroid gland were evident in human. The macroscopic difference was found with increasing age but not with sex.

Key words: Thyroid gland; Isthmus; Macroscopic

Introduction

The thyroid is the earliest endocrine glandular structure to appear in mammalian development that influences many organs of the body and plays an important role in the metabolic activities of human and other animals. Leonardo da Vinci probably found it by about 1500, and Vesalius definitely knew about it by 1543. By the early 1600s, anatomists definitely identified the thyroid gland in humans.1

The thyroid gland is a horseshoe-shaped mass clasping the upper part of the trachea.2 It consists of two symmetrical lobes united by constricted isthmus. The isthmus is a variable band of glandular tissue that unites the lower parts of the right and left lobes, and lies in front of the second, third and fourth tracheal rings. The isthmus varies greatly and sometimes is absent.3,4 Agenesis of the thyroid isthmus can also be defined as the complete and congenital absence of isthmus.5 The basic mechanism of agenesis of isthmus can be attributed to developmental anomalies. Available literature suggests that chromosome 22 has a major role in the thyroid gland development.6 A pyramidal lobe, of frequent occurrence but of variable size, extends upward from the isthmus or from the junction of the isthmus and one of the lateral lobes, usually the left7 and is connected to the thyroid cartilage and hyoid bone.8 In addition to the pyramidal lobe, there may be a
fibromuscular band known as the levator glandulae thyroideae which usually replaces the upper part of the pyramidal lobe.\(^9\) However, morphological study of thyroid isthmus bears a great importance. We have only few studies on human organs in Bangladesh, especially in their anatomical variation in size, shape and gross dimensions in comparison to those of the Western population.

**Materials and Methods**

This descriptive cross-sectional study was conducted in the Department of Anatomy, Sylhet M. A. G. Osmani Medical College (SOMC) from July 2006 to June 2007. The research work was approved by the Ethical Review Committee of Sylhet M. A. G. Osmani Medical College, Sylhet.

This study was done on 54 postmortem human thyroid glands collected from individuals of both sexes (male 43 and female 11) aged from 5 to 65 years at the autopsy laboratory of Department of Forensic Medicine, SOMC. Age and sex of cadavers were collected from records in the register book. All the samples were collected from medicolegal cases excluding hanging, poisoning, any cutting or crushing injury to the thyroid gland and known case of thyroid disease. The collected samples were fixed in 10% formal saline solution. Dissection was carried out to expose the thyroid glands. The thyroid gland was examined for the following variables—a) Presence or absence of isthmus, b) Posterior relation of isthmus, c) Length, breadth and thickness of isthmus. Among them isthmus was found in 51 cases. The samples having the isthmus (n=51) were divided into three age groups — Group A (20 years and below), Group B (21 to 50 years) and Group C (50 years and above).\(^10\)

**Measurement of length, breadth and thickness of isthmus**

The length of the isthmus was measured transversely at its superior limit, the middle part and the inferior limit with the help of a scale. The mean measurement was recorded for further use. The breadth of the isthmus was measured from superior to inferior border with a scale. Three measurements were taken at its right end, left end and middle part. The mean value was recorded as breadth of the isthmus. The thickness of the isthmus was measured anteroposteriorly at its two ends and middle part with a slide calipers. The mean value was recorded as thickness of the isthmus.\(^11\)

Statistical analyses were done by unpaired Student “t” test and one way ANOVA test using SPSS 12.0 version.

**Results**

In this study it was observed that out of 54 thyroid glands 3 (5.56%) had no isthmus. In 18 (35.29%) cases the isthmus was related to 1\(^{st}\), 2\(^{nd}\), 3\(^{rd}\) and 4\(^{th}\) tracheal rings posteriorly. Table I shows the posterior relation of isthmus of the thyroid gland. There is significant difference regarding posterior relation of isthmus in relation to tracheal rings. There is significant difference regarding posterior relation of isthmus in relation to tracheal rings. Table II shows the length, breadth and thickness of isthmus of the thyroid gland in different age groups of study population.

| Tracheal rings/Cricoid cartilage | Number of isthmus | Total |
|----------------------------------|-------------------|-------|
| 1–2                              | Group A           | Group B | Group C | Total          |
| 1–3                              | 0                 | 3       | 0       | 3 (5.56%)      |
| 1–4                              | 7                 | 9       | 2       | 18 (35.29%)    |
| 1–5                              | 1                 | 10      | 2       | 13 (25.49%)    |
| 1–6                              | 0                 | 1       | 0       | 1 (1.96%)      |
| 1–7                              | 0                 | 0       | 1       | 1 (1.96%)      |
| 2–4                              | 0                 | 0       | 1       | 1 (1.96%)      |
| 2–5                              | 0                 | 1       | 0       | 1 (1.96%)      |
| Cricoid cartilage–4\(^{th}\)     | 1                 | 1       | 0       | 2 (3.92%)      |
| Cricoid cartilage–5\(^{th}\)     | 1                 | 0       | 0       | 1 (1.96%)      |
| Cricoid cartilage–6\(^{th}\)     | 1                 | 1       | 0       | 2 (3.92%)      |
| Absent isthmus                   | 0                 | 3       | 0       | 3 (5.56%)      |
In this study it was found that the average length of the isthmus of the thyroid gland was 1.25 ± 0.54, 1.41 ± 0.64 and 1.80 ± 0.64 cm in Groups A, B and C respectively. The mean length of isthmus of the thyroid gland was highest in Group C and lowest in Group A. There was significant difference between Group A vs Group C (p<0.05).

In this study the average breadth of the isthmus of the thyroid gland was 1.50 ± 0.65, 1.65 ± 0.46 and 2.02 ± 0.52 cm in Groups A, B and C respectively. There was significant difference between Group A vs Group C and B vs C (p<0.05).

In this study the average thickness of the isthmus of the thyroid gland was 0.51 ± 0.17, 0.57 ± 0.23 and 0.53 ± 0.19 cm in Groups A, B and C respectively. There was no significant difference among the groups. There was no significant difference between males and females regarding length, breadth and thickness of isthmus of the thyroid gland (Table III).

### Discussion

In the present study, it was found that 5.56% thyroid gland had no isthmus. This observation can be compared with study done by Enayetullah11, Marshall12, Ranade et al13, Nurunnabi et al14, Dixit et al15, Prakash et al16, Tanriover et al17, Kulkarni et al18, Muktyaz et al19 and Veerahanumaiah et al20 (Table IV).

### Table II: Length, breadth and thickness of isthmus of the thyroid gland in different age groups

| Groups | Length (cm) | Breadth (cm) | Thickness (cm) |
|--------|-------------|--------------|----------------|
|        | Mean (Range) | P values | Mean (Range) | P values | Mean (Range) | P values |
| A (n=13) | 1.25 ± 0.54 (0.6–2.5) | A vs B >0.05 | 1.53 ± 0.60 (0.97–3.07) | A vs B >0.05 | 0.56 ± 0.22 (0.33–1.07) | A vs B >0.05 |
| B (n=23) | 1.41 ± 0.64 (0.53–2.6) | B vs C >0.05 | 1.68 ± 0.52 (0.66–2.6) | B vs C <0.05 | 0.50 ± 0.19 (0.23–0.93) | B vs C >0.05 |
| C (n=15) | 1.80 ± 0.64 (0.83–2.97) | A vs C >0.05 | 2.02 ± 0.52 (1.5–2.37) | A vs C <0.05 | 0.55 ± 0.13 (0.27–0.77) | A vs C >0.05 |

The post-Hoc option of analysis of variance (ANOVA) test was done to compare each group from other group for each variable. The difference was considered to be significant statistically at 5% level (i.e. p<0.05).

### Table III: Length, breadth and thickness of isthmus of the thyroid gland in male and female

| Sex | Length (cm) | Breadth (cm) | Thickness (cm) |
|-----|-------------|--------------|----------------|
|     | Mean (Range) | P values | Mean (Range) | P values | Mean (Range) | P values |
| Male (n=40) | 1.50 ± 0.65 (0.57–2.97) | Male vs Female >0.05 | 1.65 ± 0.46 (0.66–2.37) | Male vs Female >0.05 | 0.51 ± 0.17 (0.23–1.07) | Male vs Female >0.05 |
| Female (n=11) | 1.36 ± 0.65 (0.53–2.7) | | 1.98 ± 0.66 (0.97–3.07) | | 0.57 ± 0.23 (0.27–0.93) | |
| Total (n=51) | 1.46 ± 0.64 (0.53–2.97) | | 1.72 ± 0.52 (0.66–3.07) | | 0.53 ± 0.19 (0.23–1.07) | |

Unpaired Student “t” test was done to analyze data.

In this study it was found that the average length of the isthmus of the thyroid gland was 1.25 ± 0.54, 1.41 ± 0.64 and 1.80 ± 0.64 cm in Groups A, B and C respectively. The mean length of isthmus of the thyroid gland was highest in Group C and lowest in Group A. There was significant difference between Group A vs Group C (p<0.05).

In this study the average breadth of the isthmus of the thyroid gland was 1.50 ± 0.65, 1.68 ± 0.52 and 2.02 ± 0.52 cm in Groups A, B and C respectively. There was significant difference between Group A vs Group C and B vs C (p<0.05).

In this study the average thickness of the isthmus of the thyroid gland was 0.56 ± 0.22, 0.50 ± 0.19 and 0.55 ± 0.13 cm in Groups A, B and C respectively. There was no significant difference among the groups. There was no significant difference between males and females regarding length, breadth and thickness of isthmus of the thyroid gland (Table III).

### Table IV: Comparison of absence of isthmus in other studies with that in this study

| Authors and year of study | Sample size | % of absence of isthmus |
|---------------------------|-------------|------------------------|
| Marshall CF (1891)        | 60          | 10                     |
| Enayetullah (1995)        | 50          | 4                      |
| Ranade et al (2008)       | 105         | 33                     |
| Nurunnabi ASM (2008)      | 73          | 18.8                   |
| Dixit et al (2009)        | 41          | 14                     |
| Prakash et al (2011)      | 70          | 8.57                   |
| Tanriover et al (2012)    | 90          | 2.22                   |
| Veena Kulkarni et al (2011)| 20          | 10                     |
| Muktyaz et al (2013)      | 56          | 12.5                   |
| Veerahanumaiah et al (2014)| 89         | 9                      |
| This study (2007)         | 54          | 5.56                   |
In this study, the isthmus was posteriorly related with 1st, 2nd, 3rd and 4th tracheal rings in 35.29% cases. Francis\(^7\), Sinnatamby\(^8\), Kelly et al\(^4\), Woodburne\(^7\), Basmajian & Slonecker\(^8\), Kanagasuntheram et al\(^9\), Gardner et al\(^21\) and Snell\(^22\) described that the position of isthmus of thyroid gland lies against 2nd to 4th tracheal rings, which was similar to the findings in present study. Decker\(^23\), Hoyes & Karshaw\(^24\), Moore & Dalley\(^25\) and Pollock\(^26\) described that isthmus of thyroid gland lies against 2nd and 3rd tracheal rings and DeGroot\(^27\) described that it lies against 1st and 2nd tracheal rings. Enayetullah\(^11\) found that isthmus was absent in 4% cases. In his study the isthmus was related posteriorly to 2nd to 4th tracheal rings in 72% cases.\(^11\) Similar result was also observed by Begum\(^28\) in Bangladeshi people. In our study, we have seen the isthmus of thyroid gland posteriorly related also with cricoid cartilage to 4th/5th/6th tracheal rings in few cases. But other authors did not show such types of relation.

In the present study the average length of the isthmus of the thyroid gland was 1.46 ± 0.64 cm. The mean length of isthmus of the thyroid gland in male was 1.50 ± 0.65 cm and in female was 1.36 ± 0.65 cm. Standring et al\(^29\) described the length of isthmus of thyroid gland is 1.25 cm and DeGroot\(^27\) described it 1.2 to 2 cm which are similar to the present study. Similar result was also observed by Enayetullah\(^11\) and Begum\(^28\). Hoyes & Karshaw\(^24\) described it 2 cm which was higher than findings in the present study.

In the present study the average breadth of the isthmus of the thyroid gland was 1.72 ± 0.52 cm. The mean breadth of isthmus of the thyroid gland in male was 1.65 ± 0.46 cm and in female was 1.98 ± 0.66 cm. Pollock\(^26\) described that the breadth of isthmus of thyroid gland is 1.3 cm and Standring et al\(^29\) described it 1.25 cm which are lower than the findings in present study. Enayetullah\(^11\), Hoyes & Karshaw\(^24\), DeGroot\(^27\) and Begum\(^28\) found it 2 cm which is similar to finding in the present study.

In the present study the average thickness of the isthmus of the thyroid gland was 0.53 ± 0.19 cm. The mean thickness of isthmus of the thyroid gland in male was 0.51 ± 0.17 cm and in female was 0.57 ± 0.23 cm. Hoyes & Karshaw\(^24\) described the breadth of isthmus of thyroid gland is 0.2 to 0.6 cm which is similar to the findings in the present study. Similar results were also found by Enayetullah\(^11\) and Begum\(^28\).

The nature of specimens studied and the areas where studies are carried out, effect of different goiter zones, age, sex and race of population studied can contribute to the anatomical variations of the thyroid gland found in different reports by various authors.

In this study, the presence or absence, positional change and variation in gross dimension of isthmus of thyroid gland were evident in humans. The macroscopic difference was found with increasing age but not with sex. This study will also help in minimizing complications of thyroid surgery and tracheostomy. We would like to recommend further studies with larger samples and high technical support.

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