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The examinations of thyroid gland isthmus topography in foetal period development — practical importance

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The studies aimed at following isthmus of thyroid position changes in particular months of its intrauterine development. Survey material consisted of 124 human foetus thyroids aged 4–7 months of intrauterine development. The basic examination method was classical anatomical preparation. Three aspects were considered in thyroid isthmus position assessment: holotopy, skeletotopy and syntopy. The gland holotopy analysis was carried out with the usage of isthmus position indices elaborated especially for the studies. The results were statistically analysed. Thyroid isthmus was observed to change its position. Although statistically significant differences in thyroid isthmus position were not proved, some tendencies of the one-position changes were detected, especially of larynx and trachea skeletons. The tendencies were based on a relatively more significant lowering of isthmus in comparison with gland lateral lobes. The basic reason for thyroid isthmus position changes in the development period is a disproportion between foetus gland and cervix growth rates.

key words: morphometry, anatomy, thyroid, holotopy, skeletotopy, syntopy

INTRODUCTION

Thyroid gland macroscopic structure has evoked interest since the beginning of the 19th century and this is connected mainly with Basedov disease description as well as with observations made on the occasion of thyrectomy. This period also brought the first data concerning thyroid structure embryonic stage, as the primordium appears early — 3rd or 4th week of development. At the end of the 2nd month of the intrauterine period, besides its small size, thyroid gland acquires its characteristic two-lobe structure with centrally situated isthmus. Morphologists dealing with thyroid gland embryonic period observe gradual lowering of primordium position in relation with developing pharynx and tongue. These changes are clearest for thyroid isthmus, which is the main remainder of thyroid primordium. This process is the result of pharynx posterior wall rapid growth. Bibliography, however, lacks thyroid gland isthmus position analysis with regard to the foetal period. Many authors, including Peter et al. [6], Zubowskij [9] and Rybakowa [7], draw attention to the practical meaning of thyroid gland position, not only for the surgeon but also in the early neonatal period. The studies aimed at an analysis of isthmus of thyroid gland position changes in the foetal period, changes in degree definition as well as finding reasons for the changes in this not fully recognised period of thyroid development.

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MATERIAL AND METHODS

Examination material consisted of 124 human foetuses (63 male and 61 female) aged 4–7 months of intrauterine period. All the examined foetuses had been previously fixed in 10% formalin solution. Before the studies, foetus selection was performed in order to eliminate the ones with obvious developmental abnormalities. The material was divided into four age classes with subsequent month intervals. The basis for such a division was foetus calendar age defined with the usage of hospital documents (obstetrics chart). The primary examination method was classical anatomical preparation, which enabled thyroid gland position definition *in situ*. Next, the preparation area (Fig. 1) was widened revealing hyoid bone shaft as well as sternum cervical incisure. These points were used in measurements defining thyroid isthmus position. Thyroid isthmus position assessment was performed on the basis of generally accepted anatomical criteria: holotopy, skeletotopy and syntopy. In the case of glands lacking isthmus, the place of direct connection of lateral lobes was treated as "arbitrary isthmus" and its position was stated with analogous criteria as in the case of a real isthmus. The frequency of such a thyroid form, defined in bibliography as bifid gland, was 13% (16 cases). In the material analysis, the difference between "real" and "arbitrary" isthmus frequency was taken into account. Changes in the isthmus position were observed in accordance with age and sex.

Isthmus holotopy: the object of the studies was a definition of thyroid isthmus position in the neck anterior region in the area confined by hyoid bone body and sternum cervical incisure. The following notion was introduced: isthmus position index (IPI). It defines the position of the point being in the middle of isthmus height between hyoid bone and sternum. The greater is index value, the lower its examined points position. Accepted analysis method made the result independent of thyroid isthmus size, which in turn depends on the region of person habitation.

Isthmus skeletotopy: isthmus height middle point was assessed in relation with cervical spine. To avoid making too many categories of isthmus position, if the examined point was placed at the height of the intervertebral disc, it was ascribed to the level of the upper vertebra.

Isthmus syntopy: isthmus position in relation to larynx and trachea.

The above criteria thyroid isthmus position types were statistically analysed. Statistical significance was checked with the usage of chi-square test.

RESULTS

Holotopy

Isthmus position index (IPI), describing the position of isthmus height middle point in the segment between hyoid bone and sternum, varied from 33.84 to 69.89. In the value range 33.34–66.66, which was

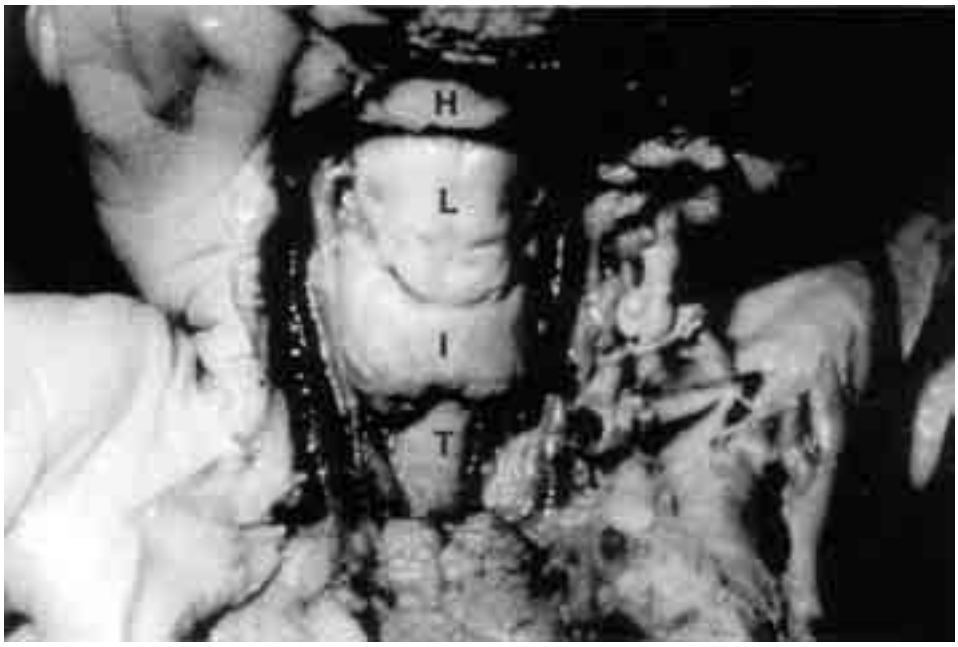

Figure 1. Position of foetal thyroid gland *in situ* — anterior view; H — hyoid bone, L — larynx, I — thyroid isthmus, T — trachea.

exactly 1/3 of the anterior neck central region, middle points of 119 isthmus heights were placed, which constituted 96% of cases. Only in 5 cases (4%) was IPI bigger than 66.66, which means that such an isthmus height middle point was placed in 1/3 superior region of anterior neck. On the basis of these data, statistical analysis was conducted and it did not reveal any interdependencies between foetus age or sex and the position of isthmus. A directly proportional dependence between isthmus and lobe positions was observed (the higher the isthmus, the higher the lobe).

Skeletotopy

The frequency of appearance of particular categories of isthmus position in relation to cervical spine is presented in Table 1. Included data analysis suggests that in the examined period, isthmus heights' middle points are placed at the altitude of C3–C6. In 4th and 5th months of foetal life, 42% of isthmuses are situated at the altitude of C3–C4 and 58% at C5–C6, whereas in 6th and 7th months only 31% of isthmuses are located at the level C3–C4 and 69% of them at the level C5–C6. Apart from the above difference, statistical analysis did not reveal any statistically significant interdependencies between age or sex and isthmus position in relation with cervical spine. The correlation between isthmus higher position and lobe adequately higher position was confirmed.

Syntopy

In the observed developmental period, thyroid gland is tightly attached to larynx and trachea cartilages. This anastomosis refers to both isthmus and poles as well as lobes medial surfaces. Isthmus and cartilage tight anastomosis can be observed in the whole examined developmental period, whereas lobe poles acquired distance from larynx and trachea in older foetuses (6th and 7th months). In the examined material, isthmus was located in the area confined by the inferior edge of cricoid cartilage arch and 5th tracheal cartilage. In order to estimate isthmus superior and inferior edge position in relation with larynx and trachea cartilages, the following rule was adopted: if the examined edge was located between cartilages at the level of circinate ligament — it was ascribed to the level of higher positioned cartilage. Figure 2 presents the absolute frequency of isthmus superior and inferior edge position categories in relation with larynx and trachea skeletons. The included data suggest that in over half of the cases (51%), isthmus superior edge reached circoid cartilage. Another 37% of isthmuses reached the first tracheal cartilage with their superior edge. Isthmus superior edge position seems not to be dependent on foetus sex and age. The position of the inferior one turned out not to be correlated with sex but it seemed dependent on age. This is confirmed by chi-square test value of 12.09 (critical value — 3.841). Isthmus inferior value lowers significantly in 6th and 7th months of foetal life. In this period, in over 75% of cases, isthmus inferior edge is located at the level of the third to the fifth tracheal cartilage. In 4th and 5th months, only about 40% of glands isthmus inferior edges are positioned.

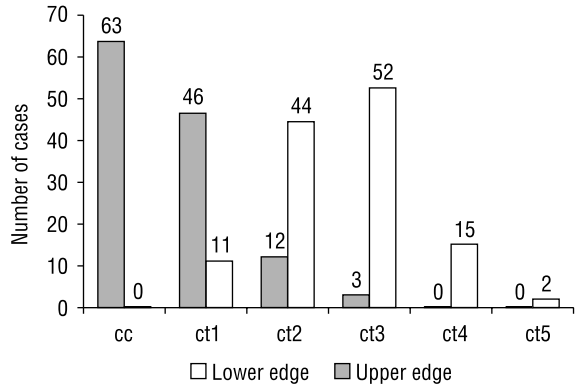

Figure 2. Relation of position thyroid isthmus to cartilages of larynx and trachea in all examined material — absolute number of cases; cc — cart. cricoidea, ct 1(5) — cartilagines tracheales 1(5).

Table 1. The frequency of appearance of particular categories of isthmus position in relation to cervical spine

Isthmus position	Age				Sex	
	IV	V	VI	VII	M	F
C3	1	1	0	0	1	1
C4	11	14	11	8	20	24
C5	20	16	15	20	37	34
C6	1	0	5	1	5	2
Σ	33	31	31	29	63	61

DISCUSSION

A number of authors point to the practical meaning of thyroid isthmus position assessment. Peter et al. [6] states that in children, until the 15th month of life, isthmus of thyroid gland position resembles the conditions in adults. Rybakova [7] confirms this opinion on the basis of ultrasound examinations of 337 thyroid glands in children aged 3–14 years. This author did not notice significant changes of thyroid

position along with age but she suggests that the gland position changes are very big and they increase in young people in puberty period. Zubowskij [9], basing on the same examination technique, observes thyroid higher position in girls. Numerous studies concern embryonic period of thyroid gland development: Weller [8], Boyd [1], Ortner [5]. Thyroid gland position in the foetal period, however, is not discussed in the available literature.

On the basis of studies presented in this paper, it is possible to state that thyroid isthmus position between 4th and 7th months of foetal development changes most significantly in relation to trachea and larynx skeleton. There is no information, however, concerning the changes in the region of neck anterior area in relation to cervical spine. Observed changes mainly consist of isthmus inferior edge. As a result, thyroid occupies a bigger and bigger area between hyoid bone and sternum. This probably results from a disproportion between thyroid intensive growth and slow growth of spine cervical segment, as described by Goździewski et al. [2]. The described influence of conditions resulting from the gland syntopy on the position changes is observed by doctors in practice: Kociałkowski [3], Li Volsi [4].

CONCLUSIONS

The knowledge of factors implicating gland position is very important in many specialisations, from obstetrician through neonatal paediatrician, neck surgeon to anatomopathologist. Due to fragmentary and incomplete data concerning thyroid gland position in foetal period, the presented data are surely of cognitive value. They enable thyroid isthmus position changes from the embryonic to the postnatal period. On the basis of these studies, it is possible to state that:

- in the foetal period, thyroid isthmus position is characteristic for many changes;
- in the examined period, isthmus position does not depend on sex;
- thyroid isthmus position and age dependence is most vivid in the context of syntopy.

The reliability of these conclusions should be supported by material random choice, careful elaboration as far as clinical and anthropological documents are concerned, uniform methods of measurement and observation as well as statistical significance of detected dependencies. The way of foetus fixation and preservation had a positive influence on the homogeneity of observations. This influence consisted in an increase in examined specimen visuality as well as in stressing the details of their external structure.

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