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Sexual dimorphism of human ribs

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Abstract

The volume of the rib cage is about 10% smaller in females than in males having the same height although the reason for this is presently unclear. The cranio–caudal inclination of ribs is greater in females than males but the length of ribs has not previously been compared between the sexes. In 23 males and 23 females studied at necropsy, body length, the length of the upper and lower limbs and the length of the thoracic spine were all smaller in females but the ratios of upper and lower limb lengths to body length and of thoracic spine length to body length were not different. By contrast, the lengths of the third, sixth and ninth ribs were not significantly different between males and females and the ratios of rib length to body length were all significantly greater in females. We conclude that in females the ribs grow longer in relation to the axial skeleton than in males.

Keywords: Chest wall; Gender; Rib cage; Lung volume

1. Introduction

Normal prediction equations for lung volume in non-smokers predict values in females that are 10–12% smaller than in males who have the same height and age (Crapo et al., 1982). The smaller lung volume of females is established in the first few years of life and has been attributed to a lower rate of alveolar multiplication (Thurlbeck, 1982), although in adults, smaller distending pressure at full active lung inflation may also contribute (Colebatch et al., 1979; Knudson et al., 1977).

Recent studies have shown that not only is there a difference in the volume of lungs between males and females having the same height, but the volume of the rib cage is also smaller (Bellemare et al., 2003, 2001). The finding of relatively smaller rib cage volume in females is surprising since the rib cage contribution to inspiratory pressure swings is apparently greater and the contribution of the diaphragm smaller in females than males (Bellemare et al., 2003). The reason for the relatively smaller rib cage volume in females than

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males is presently unclear. The volume of the rib cage is determined by the length of ribs and their geometry as well as by their cranio–caudal inclination relative to the spine. In a previous study, the cranio–caudal inclination of ribs was found to be greater in females than males (Bellemare et al., 2003). However, the length of ribs has not previously been compared between the sexes. The primary objective of this investigation, therefore, was to compare the lengths of ribs in representative groups of males and females.

2. Methods

2.1. Study population

Studies were conducted in 46 fresh cadavers (23 adult males and 23 adult females). All were caucasians less than 60 years of age and 42 were of French–Canadian descent. Forty-one died by suicide and five from alcohol intoxication. All were free of thoracic deformities. Studies were conducted in the Laboratoire de sciences judicières et de médecine légale, Government of Quebec.

2.2. Measurements

The following dimensions were measured on the right side of the body:

Length of ribs: The length of the third, sixth and ninth ribs was measured with a lead wire 1 mm in diameter and molded to fit the internal aspect of each rib. Because the ribs were sectioned at thoracotomy, the lengths of the two sections were measured separately and the two measures added to obtain rib length. Measurements were taken from the cut end of each rib to the head of the rib on one side, and to the costal cartilage on the other. These limits were marked on the lead wire with a felt pen, and the inter-marker distance was measured with the lead wire laid flat on a ruler.
Length of thoracic spine: The length of the thoracic spine was measured with the lead wire technique from the superior limit of the first thoracic vertebra to the base of the 12th.
Bisacromial distance: The distance between the acromions was measured with a pelvic caliper.
Limb length: The length of the upper limb was measured from the acromion to the wrist, and the length of the lower limb from the iliac crest to the lateral malleolus, with a metric tape.
Other measures: Height and weight were noted from the pathology report.

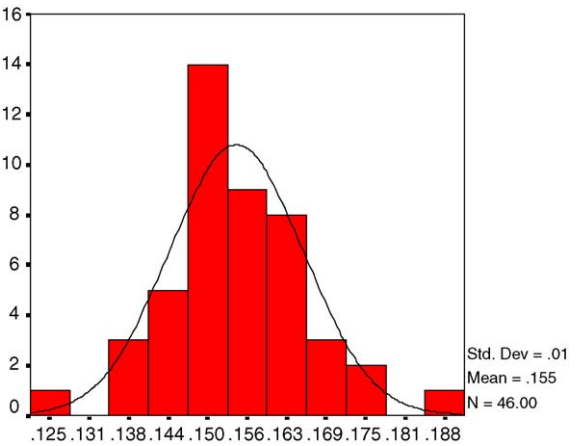

Fig. 1. Ratio of thoracic spine length/body length.

2.3. Statistical analysis

Descriptive statistics are reported as mean ± 1S.D. In addition to the measures just described, the ratios of all dimensions with body length and thoracic spine length were calculated. As shown in Fig. 1 for the ratio of thoracic spine length to body length, the distribution of these ratios closely approximate the normal distribution. Between group comparisons were carried out using the independent sample *t*-test or the Mann–Whitney *U*-test, depending on Levene's test for equality of variance of the two samples. Linear regression techniques based on the least square principle were also employed. All statistical computations were conducted with commercially available software (SPPS v10 for Windows, SPSS, Chicago, IL).

3. Results

3.1. Subjects characteristics

As shown in Table 1, height and weight were significantly lower in females than in males whereas age was comparable.