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Is the lateral angle of the internal acoustic canal sexually dimorphic in non-adults? An investigation by routine cranial magnetic resonance imaging

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ABSTRACT

The lateral angle of the internal acoustic canal is one of the measurements of petrous bone that has been previously studied for sex estimation, mostly in adults. We aimed at evaluating the effects of age, side, and sex on the lateral angle of the internal acoustic canal in pediatric patients.

Pediatric routine cranial MRI studies were retrospectively investigated for this study. The lateral angle was measured on T2-weighted axial images when the anterior and posterior lips of the meatus and the cochlea were clearly visible on the same image. The data were evaluated for age, side and sex-related changes. Although 552 temporal bones from 273 patients were inspected, due to exclusion criteria lateral angle could be satisfactorily measured only in 101 temporal bones from 58 patients. The measurements did not differ significantly between sexes. An age-related, statistically significant decrease was observed for the entire pediatric sample studied, as well as for the males, but not for females. The measurements did not differ from side to side.

The significant age-related decrease in lateral angle in male pediatric patients that was not detected in female counterparts may be the reflection of a sex-related difference in temporal bone development during childhood. Routine cranial MRI data may help investigators study age and sex-related changes in lateral angle in children.

Introduction

The petrous part of the temporal bone has been in the focus of studies aiming at documenting sexual dimorphism due to its greater preservation capability than other bones of the human skeleton. Several measurements were used in these studies for this purpose (Graw et al., 2003; Lynnerup et al., 2006; Osipov et al., 2013; Schutkowski, 1983; Schutkowski and Herrmann, 1983). The lateral angle of the internal acoustic canal is one of the measurements of petrous bone has been previously studied, mostly in adults. In the first study on sex allocation using the internal acoustic canal angle measurements, Wahl (1981) described two different types of measurement ("Ausgangswinkel – exit angle" and "Eingangswinkel – entry angle"). Later, Graw et al. (2005) mentioned these measurements as the lateral and the medial angle. This "lateral angle" in fact, is different from the "lateral angle" used in later studies (Akansel et al., 2008; Morgan et al., 2013; Norén et al., 2005), in that the later studies used the anterior wall of the meatus instead of the posterior wall used in the initial studies. These studies have suggested the likelihood of greater measurements to be associated with female sex, although with considerable overlap (Akansel et al., 2008; Graw et al., 2005; Norén et al., 2005). A more recent study

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Table 1
Age groups – sex composition of patients with mean lateral angle and standard deviation (SD) distribution among age groups.

Ages	Female (N)	Male (N)	Total (N)	Percentage (%)	Mean angle (μ°)	Angle SD (SD°)
0–2 years old	15	16	31	30.70	52.80	9.95
2–5 years old	5	10	15	14.90	50.06	8.91
5–12 years old	15	21	36	35.60	46.49	5.14
12–18 years old	9	10	19	18.80	46.10	6.91
Total	44	57	101	100.00	48.89	8.20

also reported slightly greater measurements in females, but without statistical significance (Morgan et al., 2013). Studies on lateral angle in pediatric samples are very rare. One study on cadavers of sub-adult age reported sex and age-related differences but that reported sex difference failed to provide reliable sex allocation (Gonçalves et al., 2011). In a previous study, using computerized tomography (CT) of the temporal bone, we had observed a tendency of an age-related decrease in lateral angle, but without statistical support, possibly due to the small number of pediatric cases (Akansel et al., 2008).

When radiologically studying the lateral angle in children, a major limitation is the relative scarcity of data obtained by sectional imaging studies specifically targeting the temporal bone, especially in younger patients, since most neuroimaging studies at younger age are geared toward encompassing generally the brain. Therefore, routine cranial magnetic resonance imaging (MRI) data are available in greater quantity from the very first months of age for the study of the lateral angle. In this study, we aimed at studying sex related changes in this measurement in a greater number of pediatric cases by evaluating routine cranial MRI data. All imaging studies were performed for clinical reasons; hence, the study sample is not 'normal'. However, since measurements in patients with severe congenital deformities that affect cranium were not possible, the group where adequate measurements were made most likely represents a cohort adequately representing a normal population.

Materials and methods

Patients

The study was approved by the research ethics committee of our hospital (Kocaeli University Hospital, KOU KAEK 2015/324). Initially 552 temporal bones from 273 patients were inspected. Due to the exclusion criteria (absence of suitable images to measure the angle caused by the artifacts due to patient motion, or distortion due to poor patient positioning/slice angulation, severe congenital anomalies and cerebellopontine angle masses), a total of 101 ears were successfully measured in 58 patients. The inclusion criteria were age 0–18 years, clear visibility of the internal acoustic canal and the anterior and posterior lips of the meatus and the cochlea on the same T2-weighted axial image.

The sex and age distribution of the sample is given in Table 1. Three out of 101 measurements were made on the same patients at different ages. The results were the same when measurements from these patients were excluded.

MRI technique

Two hundred and forty six patients were scanned using a 1.5 T scanner (Philips Intera, Eindhoven) and 27 using a 3.0 T scanner (Philips Achieva, Eindhoven), T2-weighted axial images used in this study were obtained using the following parameters: TR: 2200/TE: 120, FOV: 210, acquisition matrix: 264 × 178, NEX: 1, thickness: 4.0 mm, gap: 1.0 mm, as part of the routine head MRI.

Measurement of the lateral angle

Lateral angle of the internal acoustic canal was measured using a modification of the technique described by Akansel et al. (2008) while using CT. The model study used the incudomalleal joint as a landmark and used the next higher slice to ensure that the measurement was obtained taking into consideration the most pointed apex of the internal acoustic canal. Since incudomalleal joint cannot be reliably identified on routine head MRI studies, we sought an alternative landmark to ensure data consistency. Our solution was to replace the incudomalleal joint with the visibility of at least two turns of the cochlea on a T2-weighted axial image, as a requirement. Since we evaluated routine head MRI studies, the next higher slice was always well above the internal acoustic canal, thus we made our measurements on the slice with at least two turns of the cochlea and the anterior and posterior lips of the meatus clearly visible (Fig. 1). The measurements were made digitally using the software available in the picture archiving and communication system (PACS).

To evaluate if the above mentioned measurement modification caused a significant difference in outcome, we conducted a preparatory study in which a total of 30 internal acoustic canals were evaluated (GO KAEK 2016/248). We retrospectively made measurements by using both techniques on CT images of the temporal bones obtained for ear-related problems in 19 patients.

To determine intra- and inter-observer reliability, three different observers measured the lateral angle of 10 randomly selected patients in our sample for three times.

The lack of significant difference between measurements from either side in adults has been documented (Norén et al., 2005).