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# Three-dimensional chest computed tomography analysis of thoracic deformities in patients with microtia

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Incidence;
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**Summary** *Objective:* The objective of this study was to identify the incidence and characteristics of congenital thoracic deformities in patients with microtia and to investigate the interaction between microtia and thoracic deformities.
*Methods:* A total of 239 consecutive patients received a preoperative three-dimensional chest computed tomography (3-D chest CT). A retrospective study was performed with the clinical and imaging data from March 2013 to December 2013. Pearson $\chi^2$ test and Spearman analysis were used to analyze the interaction between microtia and thoracic deformities.
*Results:* With the 3-D chest CT images, a total of 68 cases (28.5%) were documented with thoracic deformities including 60 cases (25.1%) with rib anomalies, 20 cases (8.4%) with spinal deformities, and 12 cases (5.0%) with both rib anomalies and spinal deformities. The incidence of rib anomalies ($P = 0.049$) and spinal deformities ($P = 0.000$) varied with grades of microtia. The incidence of rib anomalies was slightly positively correlated with the incidence of spinal deformities in patients with microtia ($r = 0.243$).
*Conclusions:* The incidence of congenital thoracic deformities was high in patients with microtia. We observed a higher incidence of thoracic deformities in patients with a more serious grade of microtia. Microtia with thoracic deformities may involve a new syndrome previously undiscovered or just another extension with the very wide spectrum of microtia.


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## Introduction

Costal cartilage grafting for auricular reconstruction has been widely accepted as the first choice for patients with microtia.[1–3] The surgery focuses on the three-dimensional costal cartilage framework, so the harvest of stable rib cartilage is mandatory for fine framework fabrication and successful auricular reconstruction. Preoperative information with regard to the state of the rib cartilage is crucial; however, conventional methods such as physical examination or chest radiography have been limited because of clinicians' inability to gain accurate information about the rib. Based on the computed tomography (CT) images, we could determine the availability of rib cartilage so that the appropriate method was used preoperatively to achieve the best result. To our knowledge, prior studies have shown very little information on the thoracic deformity of microtia. The purpose of our study was twofold. First, we sought to determine the incidence and characteristics of thoracic deformities in patients with microtia. Second, we wanted to increase the awareness of a spectrum of manifestations in which the auricular abnormalities may be obvious and easily appreciated at birth in contrast to the thoracic deformities, which might be frequently overlooked until a clinically recognizable thoracic deformity develops in later life.

## Patients and methods

The retrospective study was performed in the Department of Auricular Reconstruction and Radiology at the Plastic Surgery Hospital of Peking Union Medical College. From March 2013 to December 2013, a total of 239 consecutive patients with microtia ($n = 239$, 184 males, 55 females, range 5–56 years, mean age 11.2 $\pm$ 6.7 years) were admitted to the our center. The classification and treatment of the patients depend on the sides and the grades[4] of microtia (unilateral = 226, bilateral = 13; microtia I = 22, microtia II = 183, microtia III = 34). The grade of microtia varies from the complete absence of auricular tissues (anotia) to a small and incomplete ear with or without an atretic canal (Figure 1).

The CT scan plus three-dimensional reconstruction covering the thorax were performed using a helical technique (Brilliance CT 64 slice, Philips medical systems, Cleveland, Ohio, USA) (tube voltage 120 kVp, tube current 220 mA s, collimation 0.6 mm, pitch 0.8, rotation time 0.75 s, matrix 512 $\times$ 512, and field of view (FOV) 350 mm). After reconstruction, the images were transferred to a standard workstation (Extended Brilliance™) for image processing and analysis. To determine the presence of rib anomalies and spinal deformities, two radiologists with 10 years of working experience and two experienced plastic surgeons reviewed all images in this double-blind study.

## Statistics

SPSS version 17.0 was used in all data analyses. The Pearson $\chi^2$ test and Spearman analysis were used to determine the incidence of rib anomalies and spinal deformities, as well as the interaction between microtia and thoracic deformities. The differences with a $P$-value $<0.05$ were considered as statistically significant.

## Results

### Rib anomalies in microtia

Abnormalities of ribs can be numerical (e.g., >24 or <24 ribs) or structural variations (e.g., bifid, fused, and irregular ribs, or cervical ribs).[5–8] Three-dimensional (3-D) chest CT radiographs of 239 cases were evaluated; a total of 68 cases (28.5%) were documented with thoracic deformities including 60 cases (25.1%) with rib anomalies. The patients with rib anomalies include 12 cases (5.0%) with numerical variations and 48 cases (20.1%) with structural changes. In the 239 cases, hypoplastic ribs (18.8%) were the most common pattern of structural anomalies, followed by bifid ribs (2.9%) and fused ribs (1.7%). In addition, absent or rudimentary 12th ribs were observed frequently (16.3%), whereas a few cases with other rudimentary ribs were noticed (Figures 4 and 7). Bifid or forked ribs were found in seven cases (2.9%) and they involved the third or fourth rib (Figure 2). In this anomaly, the anterior portion of the rib is duplicated. Fused ribs or bone bridging was observed in four cases (1.7%), which may involve the posterior or anterior portion or whole ribs (Figure 3). It is probably related to a segmentation defect while it may be seen in association with vertebral segmentation anomalies. In variations of rib number, absent ribs (3.3%) were observed as the most common changes, especially the unilateral or bilateral 12th-rib deficiency (Figure 7). Cervical ribs were noticed in two cases (0.8%) in this series. At radiography, cervical ribs may be unilateral or bilateral, and the size ranges from small ossicles to long bones that often fuse or

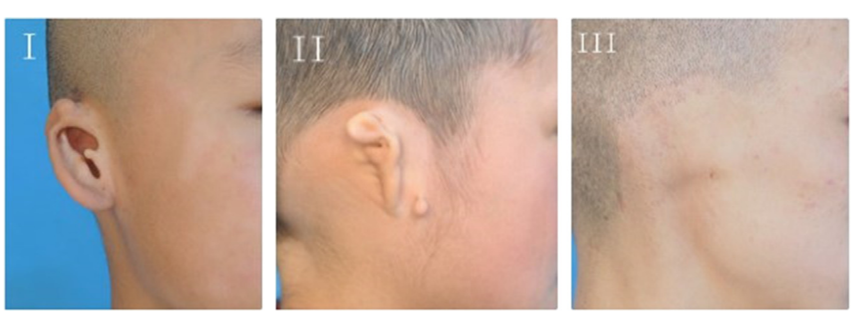


**Figure 1** The ears with microtia from Grade I to III.