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Ipsilateral Hypertrophy of the Mastoid Process in Surgical Cases of Congenital

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Objectives
Secondary musculoskeletal asymmetry is one of the main complications of congenital muscular torticollis (CMT). Common examples include: cervical and thoracolumbar scoliosis, craniovertebral abnormalities and other various forms of craniofacial asymmetry, which include depression of the frontal bone and zygomatic arch on the CMT side, posteriorly positioned ear on the CMT side, deformational plagiocephaly on the non-CMT side, and deviation of the chin towards the non-CMT side. From our clinical experience, we hypothesized that ipsilateral hypertrophy of the mastoid process on the side of CMT is common in patients with severe CMT. To the best of our knowledge, there have been no reports on the volumetric asymmetry of the mastoid process in CMT patients. Therefore, the Objectives of this study were to verify ipsilateral hypertrophy of the mastoid process in surgical patients with CMT and to analyze this change in reference to age.

Methods
This is a case-control study in a tertiary hospital. Surgical cases of CMT were enrolled, along with the age- and gender-matched controls. The volume of mastoid process was calculated and compared for both groups on the computed tomography axial images. A linear regression analysis was performed between the age at the time of computed tomography and the intra-subject volume difference of the mastoid process in the CMT group.

Results
A total of 212 CMT patients (age, 50.9 ± 44.3 months) and 212 controls (age, 50.4 ± 44.2 months) was included. The volume of the mastoid process in the CMT side (32.2 ± 30.3 cm3) was significantly larger than that of the non-CMT side (21.9 ± 22.8 cm3) in the CMT group, as well as that of the right (21.6 ± 24.6 cm3) or left (21.2 ±23.8 cm3) side in the controls ($p > 0.05$). The volumetric asymmetry of the mastoid process was 9.3 times greater in the CMT group compared to that of the controls. The ipsilateral hypertrophy of the mastoid process in CMT group significantly increased with age.

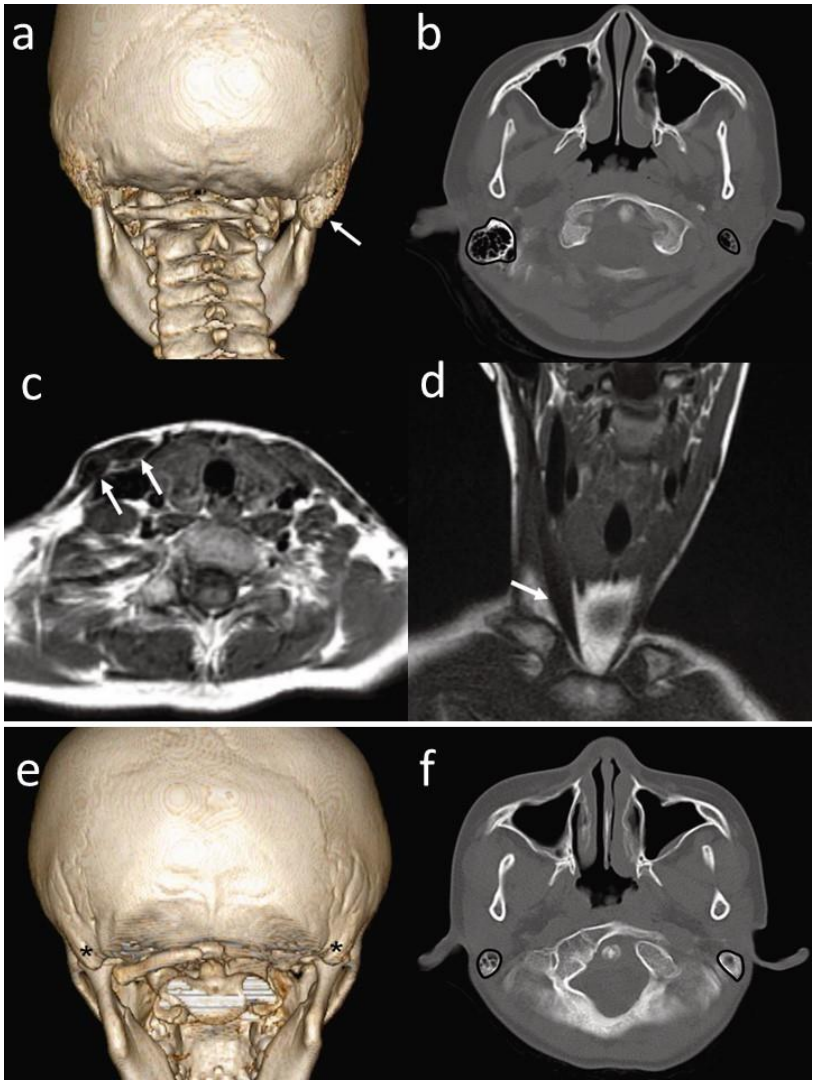
Conclusions
This is the first study showing volumetric change of the ipsilateral mastoid process by CMT. Chronic mechanical strain by the contracted ipsilateral SCM muscle of CMT could be responsible for ipsilateral hypertrophy of the mastoid process. Ipsilateral hypertrophy of the mastoid process could reflect severe CMT that requires surgical treatment. We think

that the ipsilateral hypertrophy of the mastoid process in CMT seems to be one of in vivo examples of functional adaptation of bones to mechanical strain. It is evident that CMT causes asymmetry of the mastoid process and it should be included in the list of craniofacial asymmetries caused by severe CMT. There may be a progression of skeletal deformities if the contracted SCM muscle is not released. Timely surgical release should be emphasized to minimize asymmetric development of the craniofacial skeleton, including ipsilateral hypertrophy of the mastoid process.

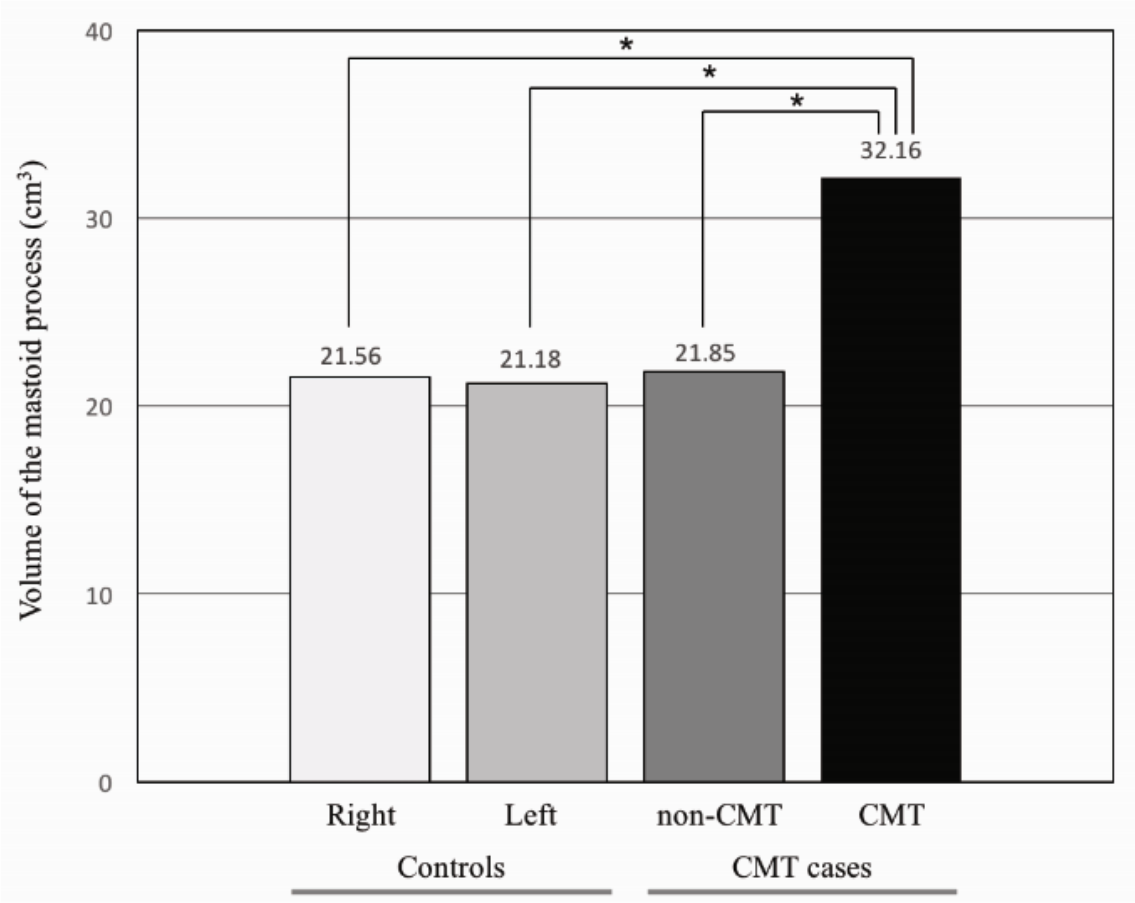
TABLE 1. Characteristics of the Subjects

Characteristics	CMT group	Control group	*p* value
Number of subjects	212	212	
Number of subjects by gender (men:women)	125: 87	125:87	1.000
Age at the time of CT (months; mean ± SD)	50.91 ± 44.30	50.35 ± 44.24	0.897
Number of subjects by CMT side			
Right CMT	125 (59%)	NA	
Left CMT	87 (41%)	NA	

SD, standard deviation; CMT, congenital muscular torticollis; NA, not applicable.



Ipsilateral hypertrophy of right mastoid process of a nine-year-old patient with right congenital muscular torticollis (CMT). The three dimensional computed tomography (CT) image shows hypertrophy of right mastoid process of the CMT side (arrow) compared to the mastoid process of the non-CMT side (a). The axial computed tomography image also shows hypertrophy of right mastoid process of the CMT side, where solid lines show bilateral mastoid process (b). The magnetic resonance mages of the neck in the above patient with right CMT reveals low signal intensity (arrows) within right sternocleidomastoid muscle due to fibrotic change on axial (c) and coronal T1 weighted images (d). A nine-year-old control girl does not show any significant difference between right and left mastoid process on the three dimensional (e) and axial CT images (f), where asterisks and solid lines indicate bilateral mastoid process.



Comparison of the volume of the mastoid process. The congenital muscular torticollis (CMT) side in the CMT group showed significantly larger volume of the mastoid process compared to that of non-CMT side or that of either side of the controls. An asterisk (*) indicates $p < 0.05$. There was no significant difference among the volume of the mastoid process in the non-CMT side of the CMT group