

Research Article

Frequency and Ct Scan Pattern of Incidental Mastoid Air Cell Opacification

Awash Solomon Gebremariam¹ , MusieNegasi Gebreslase^{2,*} ,
Birhanu Kassie Reta³ , Haftom Guesh Girmay² , Kibrom Tsegay Hailu⁴ ,
Million Abraha Zeray⁵ 

¹Department of Radiology, Addis Ababa University, Addis Ababa, Ethiopia

²Department of Obstetrics and Gynecology, Aksum University, Aksum, Ethiopia

³Department of Pathology, Aksum University, Aksum, Ethiopia

⁴Department of Emergency Medicine and Critical Care, Aksum University, Aksum, Ethiopia

⁵Department of Surgery, Aksum University, Aksum, Ethiopia

Abstract

Background: Incidental findings of mastoid opacification are increasing as cross-sectional imaging is used more often. Mastoid opacification observed on imaging for unrelated clinical purposes is known as incidental mastoid opacification (IMO). Consultations with otolaryngologists are frequently the result of these findings. The purpose of this study was to ascertain the radiological patterns and frequency of IMO on CT imaging. **Methodology:** Patients who had CT imaging for non-otologic indications between August 2021 and August 2022 were reviewed in a retrospective cross-sectional study carried out at TikurAnbessa Specialized Hospital. **Findings:** 123 (8.4%) of the 1,466 patients experienced incidental mastoid opacification. Of these, 54 (43.9%) had bilateral involvement and 69 (56.1%) had unilateral involvement. Four (3.3%) had a combination of partial and complete opacification, 22 (17.9%) had complete opacification, and 97 (78.9%) had partial opacification. In 48 cases (39%), there was concurrent middle ear opacification. Despite these results, radiology reports only reported mastoid opacification in 31 cases (25%) and described it as either otomastoiditis or simple opacification. Only 7 patients (5.7%) were evaluated by an otolaryngologist, and no active mastoiditis was found. In conclusion, 8.4% of patients having CT scans for non-otologic reasons had incidental mastoid opacification. Complete opacification and concurrent middle ear involvement increased the likelihood of reporting. Few cases were referred for ENT evaluation, though, and most were clinically insignificant. These results emphasize how crucial it is to interpret data carefully in order to prevent needless referrals.

Keywords

CT Scan, ENT, Incidental, Mastoid Opacification

*Corresponding author: musienegasi79@gmail.com (MusieNegasiGebreslase)

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1. Introduction

The true mastoid process, part of the temporal bone, develops air cells through a process called pneumatization [1, 2]. Mastoiditis, an inflammation of the mastoid bone, can result from infections that extend from the middle ear due to the connection between the mastoid cells and the middle ear [3, 4]. It is more extensively implicated than in isolated acute otitis media or otitis media with a simple effusion [5, 6]. Acute mastoiditis with or without destructive features of the bony septa is known as incipient and coalescent mastoiditis, respectively [7]. The classic diagnosis of acute mastoiditis is described as acute otitis media features on otoscopy, with local mastoid inflammatory findings such as sagging of the posterior-superior wall of the external auditory canal and auricular protrusion, supported by mastoid inflammatory changes seen on radiological or surgical findings [8]. Although imaging is often not necessary in the presence of typical manifestations of mastoiditis, computed tomography (CT) may be indicated to confirm atypical presentations, to help identify coalescent mastoiditis, and to determine any intracranial extension [9, 10]. In cases of complicated acute mastoiditis (AM), a CT scan is helpful for diagnosis, as mastoid air cells are best evaluated with CT imaging of the mastoid segment [11, 12]. The presence of opacification of mastoid cells is not always an indicator of AM, as there are other causes such as infective exudate, mucosal thickening or edema, sterile fluid, granulation tissue, or cholesteatoma, and in cases of otitis media with effusion (OME) [13-15].

Reports of incidental imaging evidence of mastoiditis that are unrelated to the clinical reasons for imaging are currently increasing unnecessary ENT referrals, resulting in prolonged hospital stays and increased financial burden for patients [16, 17]. Therefore, to differentiate opacifications due to possible transient findings from acute mastoiditis (AM), clinical correlation is mandatory, as true mastoiditis tends to present acutely in clinically sick patients [16, 18]. However, atypically presented cases such as subclinical mastoiditis may lead to catastrophic complications like meningitis, lateral sinus thrombosis, and brain abscess, where CT scan characteristics of mastoid opacification with bony involvement are helpful [20-24].

Despite the fact that most incidental observations have no clinical significance, doctors are torn between whether or not to treat them. The proportion of incidental findings in asymptomatic patients can be used to boost decision-making confidence. Therefore, this study is aimed to assess the frequency of mastoid opacification and how it has clinical significance at different population among patient who underwent head and neck CT and brain imaging. As to our knowledge this study is the first to be done in the study area and it will help as a baseline for the future studies on this area.

2. Materials and Methods

The study was done at Tikur Anbesa Specialized Hospital

(TASH), which is part of the College of Health Sciences at Addis Ababa University, located in the capital city of Ethiopia. TASH is the largest referral and the main teaching hospital in the nation. Equipped with two TE-Intima-64 CT scanners, the hospital provides tertiary-level care and 24hrs emergency services. The study took place over the course of one year, from August 2021 to August 2022.

It was a retrospective cross-sectional study focusing on patients who underwent computed tomography (CT) imaging for non-otological reasons. The source population included all patients who had brain or head and neck CT scans at TASH during the study period. The study population, however, was specifically comprised of patients whose CT images revealed mastoid opacification, but whose imaging was done for reasons unrelated to ear or otologic conditions.

Patients included in the study had CT scans of the brain, head, or neck, which could include brain CT with or without contrast, CT head scans for stroke protocols, head and neck CT, maxillofacial CT, orbital CT, and paranasal sinus (PNS) CT. The study focused on patients aged 2 years or older, as the mastoid air cells become visible on CT scans by this age. Patients who had CT scans for otologic concerns, trauma, or pharyngeal cancer, or those who underwent surgery involving the basal skull or adjacent tumors affecting the mastoid air cells, were excluded from the study.

The sampling technique used was non-probability sampling, where all patients who had CT scans of the brain and head/neck for non-otological indications during the study period were included.

Data collection was done using a structured questionnaire. Patient information was gathered by reviewing their charts and electronic records from the I-care system at TASH. A detailed review was also conducted of the logbooks of residents involved in neuroradiology during the study period. The CT images and their corresponding reports were examined, and relevant findings were recorded.

To ensure the quality and reliability of the data, a pretest was conducted on the questionnaire to assess clarity and validity. Adjustments were made based on feedback from the pretest to improve the data collection process.

Once the data were collected, they were checked for completeness and accuracy. The data were entered into EpiData version 3.1 for initial cleaning and coding to prevent any logical errors. The data were then exported to SPSS version 24 for analysis. Descriptive statistics, including frequencies and summary measures, were calculated and presented in tables and figures.

Ethical considerations were strictly followed throughout the study. To ensure patient confidentiality, all personal information was anonymized. Ethical clearance was obtained from the Institutional Review Board (IRB) of the Department of Radiology at Addis Ababa University and other relevant authorities before the study commenced.

3. Results

During the study period, there were 1466 patients who had head and neck or brain CT done for non-otologic indications who fulfilled the above-mentioned inclusion and exclusion criteria. Among these 123 patients had incidental findings of

mastoid opacification, making the frequency of incidental mastoid opacification 8.4%. The male to female ratio in this study was 1:1.08 with the males representing (48%) of the study participants. The mean age of the patients was 43.63yrs (± 21.98 yrsSD) with the minimum and maximum ages 2yrs and 86yrs respectively (Table 1).

Table 1. Demographic characteristics and clinical indications for imaging in tash patients with incidental mastoid air cell opacification, 2022g.c., addis ababa, ethiopia.

		Frequency	Percentage
Sex	Female	64	52.0
	Male	59	48.0
Age	≤ 15 years	18	14.6
	16 to 30 years	18	14.6
	31 to 45 years	29	23.6
	46 to 60 years	28	22.8
	61 to 75 years	23	18.7
	≥ 76 yrs	7	5.7
	Cerebrovascular accident	44	35.8
Indications for imaging	Cancer staging/treatment response which doesn't involve mastoid air cells.	31	25.2
	Intracranial mass evaluation	13	10.6
	Altered mental status	10	8.1
	CNS infection	5	4.1
	Headache	5	4.1
	Neck and face benign mass evaluation	4	3.3
	Seizure	4	3.3
	Cranial and/or spinal malformations	2	1.6
	Others	5	4.1

71% of patients had brain CT done. The rest, close to quarter, had other imaging protocols. (See Figure 1). The most common indications for the imaging evaluation, were stroke (n=44, 35.8%), evaluation of malignancy (n=31, 25.2%), and intracranial mass evaluation (n=13, 10.6%).

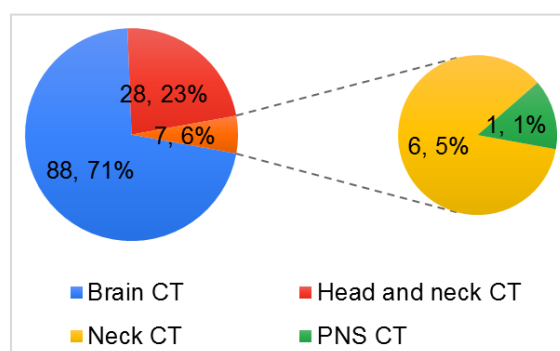
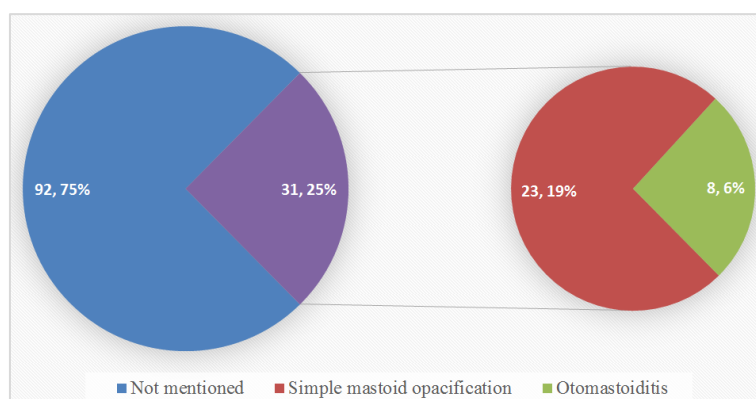
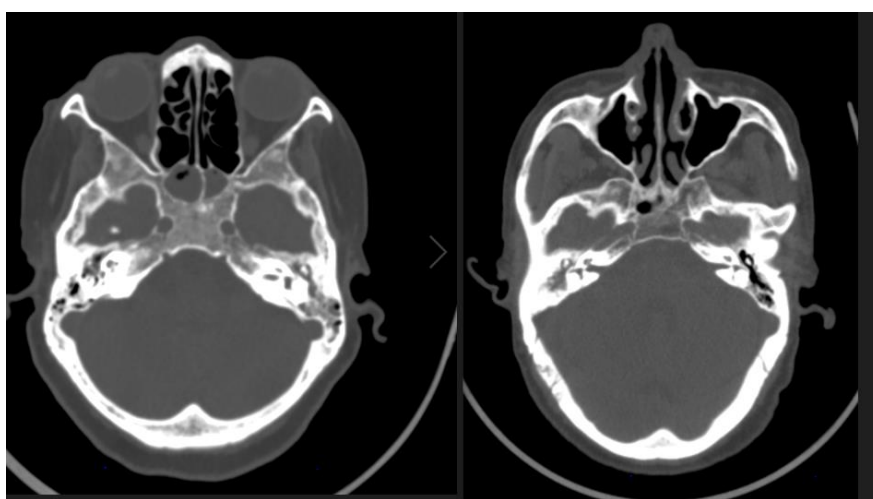


Figure 1. Types of CT scan done in TASH patients with incidental mastoid air cell opacification, 2022G.C., Addis Ababa, Ethiopia.

Table 2. Imaging findings in TASH patients with incidental mastoid air cell opacification, 2022G.C., Addis Ababa, Ethiopia.

		N=123	
		Frequency	Percentage
Mastoid opacification/mastoiditis side	Unilateral	69	56.1
	Bilateral	54	43.9
	Partial	97	78.9
Mastoid opacification/mastoiditis severity	Complete	22	17.9
	One side partial/ other side complete	4	3.3
	Simple fluid filled or mucosal thickening	117	95.1
Characteristics of mastoid opacification	Mastoid air cells bone sclerosis	6	4.9
	Mastoid air cells bone erosion /coalition	0	0
	No	75	61.0
Concomitant middle ear opacification	Yes	39	31.7
	One side yes/ other side no	9	7.3

**Figure 2.** Ct imaging reports in tash patients with incidental mastoid air cell opacification, 2022g.c., addis ababa, ethiopia.**Figure 3.** Axial computed tomography scan (bone window) at the level of the temporal bones demonstrating (A) bilateral partial mastoid opacification (arrows) with associated middle ear opacifications (arrow head) and (B) right complete mastoid air cells opacification (arrow) with associated middle ear opacification (arrow head).

Among the 123 cases of IMO the patterns of mastoid air cell opacification, as listed in Table 2, were unilateral 69 (56.1%) and bilateral 54 (43.9%). And the severity of mastoid opacifications was demonstrated as partial 97 (78.9%), complete 22 (17.9%) and one side partial and other side complete 4 (3.3%). The most common characteristics of mastoid opacification was as simple fluid or mucosal thickening 117 (95.1%), sclerosis 6 (4.9%) but no mastoid air cells bone erosion/coalition identified.

The percentage of patients who had mastoid opacification mentioned, either as simple mastoid opacification or otomastoiditis, in their imaging reports was 31 (25%), see Figure 3. Among these 11 (35.4%) had recommendation for ENT evaluation and 20 (64.6%) had no recommendation.

There was significant association between mentioning MO in radiology reports and severity of the mastoid opacification (p value= 0.024). Among 97 patients who had partial MO, 20 (20.6%) were mentioned in the report while 11 (42.3%) were

mentioned among 26 patients with complete opacification.

Among the study participants, only 7 (5.7%) patients had ENT evaluation done. Among these, 3 (42.9%) had recommendation for evaluation on CT report. Conversely, among 11 patients who had recommendation on CT report for ENT evaluation, only 3 (27.3%) had ENT evaluation done.

Among 31 patients who had mastoid opacification mentioned, 6 (19.4%) had ENT evaluation done while among 92 patients who had no mentioning of MO on the CT report only 1 (1.1%) had ENT evaluation done. Conversely among 7 patients who had ENT evaluation done 6 (85.7%) had MO mentioned in their reports (see Figure 4). The results of ENT evaluation were normal in 4 of these 7 patients. The other findings were acute otitis media ($n=1$), serous otitis media ($n=1$), and bilateral mild SNHL ($n=1$). The patient with acute otitis media was started on PO antibiotics; otherwise, all the other patients did not receive antibiotics.

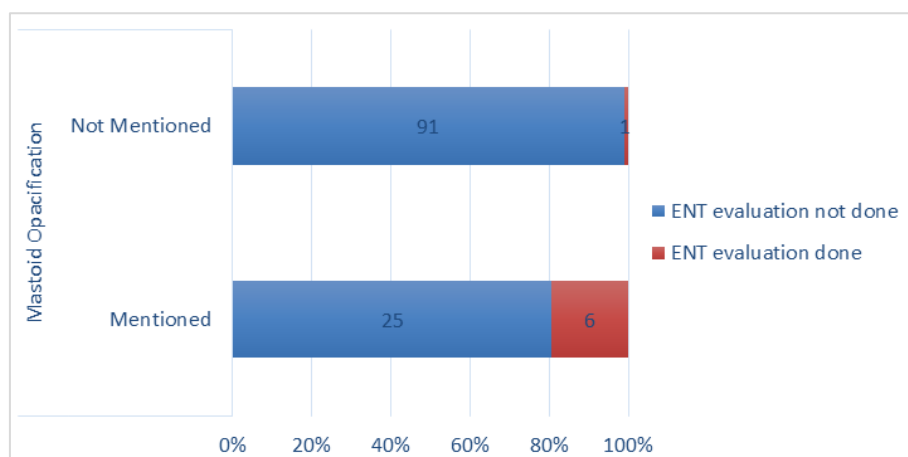


Figure 4. Relationship between mentioning of mastoid opacification on imaging reports and ENT evaluation in tash patients with incidental mastoid air cell opacification, 2022g.c., addis ababa, ethiopia.

4. Discussion

The pooled (including both children and adults) frequency of mastoid opacification in this study, as assessed on CT images, was found to be 8.4%, with no significant gender differences and nearly equal male-to-female distribution. Mughal et al. [12] (2021) also reported a pooled prevalence of 8.4% for IMO, with the prevalence among children of 17.2% and among adults of 6.1%, with a 95% CI of 3.3-9.6%. Similarly, Wilkinson et al. [21] investigated incidental mastoid opacification on CT imaging in the adult population and discovered an incidence of 11%, which is greater than predicted considering the lower prevalence of middle-ear illness in adults. In addition, Abbas et al. [17] conducted a retrospective case series in the adult population, finding a

5.8% frequency of radiological mastoid opacification on MRI images. In contrast, another study by Singh et al. [19] showed mastoid opacification to be common, with a 21.4% prevalence and no significant gender differences. A report by Balci et al. [20] showed incidental opacification in 27.1% of patients, nearly matching the former study's statistic but significantly higher than ours. Previous studies have shown that there is a large difference in the prevalence of IMO among studies that used imaging reports versus those that directly analyzed images. The prevalence was lower among those that used reports as a data source. In other words, most conventional and routine radiology reports do not include IMO in their findings. Similarly, in our study, only one-quarter of reports included IMO. The meta-analysis mentioned above indicated that the prevalence of IMO calculated from studies that used image reports is 3.5%, whereas from studies that used direct image review is 14.5% [23]. In our study, 123

patients had IMO, making the frequency from direct image study 8.4%, and 31 patients had this mentioned in their reports, making the prevalence from reports 2.1%. This finding is lower than that of the meta-analysis but still demonstrates that only a quarter of IMO cases are mentioned in radiology reports.

In our study, among 123 patients with IMO, 7 (5.7%) patients had a record of ENT evaluation. Among these, 3 (42.8%) had evidence of otological disease with no mention of mastoiditis. Polat et al. [22] looked at 275 persons who had been diagnosed with mastoiditis based on a radiologist's report of fluid in mastoid air cells. Only 17% of these patients had otological illness, according to clinical and otological assessment. Similarly, to determine the occurrence of incidental mastoid opacification, Sayal et al. [4] showed that none of the patients who were reported as having mastoiditis or mastoid effusion were diagnosed with mastoiditis, and only 8.8% of the cohort had evidence of any otological disease in this asymptomatic patient group. As compared to this study, our findings are significantly higher, most likely because of the very low number of patients with ENT evaluation.

In our study, there was no evidence of mastoid septa erosion or coalition in cases with IMO. Also, among those who had clinical evaluation, there was no evidence of otomastoiditis. A systematic review that included 16 studies that assessed IMO showed that there was no report of mastoiditis in any of them [24]. Mastoiditis is mostly a clinical diagnosis, with imaging used to assess for complications. If, however, the infection is subclinical, we could expect bone erosions and coalitions as evidence on imaging.

5. Conclusion

The frequency of IMO in our study population is found to be 8.4%. The most common imaging pattern of these IMO is unilateral 69 (56.1%), partial mastoid opacification 97 (78.9%) and simple fluid or mucosal thickening 117 (95.1%). But no mastoid air cells bone erosion/coalition identified.

The most common imaging findings which increase the likelihood of reporting of this IMO were complete MO and concomitant middle ear opacifications. There was no evidence of clinical mastoiditis among patients with imaging findings of IMO. The most common findings in patient evaluated by ENT doctors after diagnosis of IMO on imaging were normal or unremarkable.

6. Recommendations

We recommend that further prospective study done in collaboration with ENT specialists to clearly know the clinical significance of finding IMO on imaging.

In making recommendations for ENT evaluation of IMO on image reports, we recommend to use severity and con-

comitant middle ear opacification as supportive evidence to reduce unnecessary clinical examination.

7. Limitations

There was inadequate proportion of patients with clinical or ENT evaluation which limited our ability to make reliable clinical correlation. The data collection method also retrospective chart and image review.

Abbreviations

CT	Computed Tomography
ENT	Ear, Nose, and Throat
IMO	Incidental Mastoid Opacification
OME	Otitis Media with Effusion
SNHL	Sensorineural Hearing Loss
TASH	Tikur Anbessa Specialized Hospital

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Author Contributions

Awash Solomon Gebremariam: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

MusieNegasi Gebreslase: Data curation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing

Birhanu Kassie Reta: Conceptualization, Data curation, Formal Analysis, Validation, Visualization, Writing – original draft, Writing – review & editing

Haftom Guesh Girmay: Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Kibrom Tsegay Hailu: Data curation, Investigation, Supervision, Validation, Writing – original draft, Writing – review & editing

Million Abraha Zeray: Data curation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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