



Evaluation of Pneumatization of Mastoid Air Cells Using CBCT in Patient Referring to The Department of Oral and Maxillofacial Radiology, Tabriz Faculty of Dentistry in 2016

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Abstract: *Introduction & Objective:* Air-filled canals that is originated from the mastoid process trunk of the temporal bone and the middle ear have been introduced as mastoid air cells. One of the most important aspects of investigation of mastoid air cells pneumatization is that it can be considered as a prognosis for the infection of the middle ear. Cone beam Computed Tomography (CBCT) is a new technique recently known as dental CT imaging, which is used in dentistry. Regarding the fact that in previous studies, the vast age range has been studied and most of them were based on gender and only CT technique was used for the purpose of evaluation of mastoid air cells pneumatization, therefore, the present study was conducted to investigate the mastoid air cells pneumatization using the CBCT technique and compare it in different age groups and genders. *Materials and Methods:* In this descriptive-analytical study, a stereotypes of CBCT of 200 patients (100 males, 100 females) who referred to Oral and Maxillofacial Radiology Department of Tabriz Dental School were used and samples were examined in coronal, axial, and sagittal sections. Data were analyzed by descriptive statistics (percentage) and Chi-square test by SPSS 16 software. The value of p-value in this study was considered as 0.05. *Results:* The Chi-Square test showed a significant difference in the frequency of pneumatization based on gender ($p < 0.05$). Chi-square test showed a significant difference in the frequency of pneumatization degree based on age groups ($p < 0.05$). Chi-square test did not show a significant difference in the frequency of pneumatization based on the side of mastoid bone ($p > 0.05$). *Conclusion:* The results of present study showed that the degree of pneumatization of mastoid air cells has a significant difference based on gender and age groups and CBCT technique is a suitable method for studying mastoid air cells pneumatization.

Keywords: Cone Beam Computed Tomography, Pneumatization, Temporomandibular Joint

INTRODUCTION

One of the most important considerations of mastoid air cells pneumatization is that it can be considered as a prognosis for the onset of an infection in the middle ear, as the risk of middle ear infection is reduced with the weakness of pneumatization (Bayramoğlu et al., 1997). If the treatment of acute or chronic middle ear mastoidal air cell infection fails, the infection can spread to other areas of the head and neck, even the infection causes a risk to life such as meningitis, subdural infections, brain abscess infection of the petrous bone (petrous apicitis)

located between the inner and middle ears, causes infection of the temporal bone (osteomyelitis), facial paralysis with facial inflammation, and paralysis of chronic pressure on the nerve of the face (Anatomy, 2005; Gray, 2009).

The precise mechanism of mastoid air cells pneumatization the factors affecting it have not been accurately identified, but it plays an role in the storage of air and acts as a vessel to reduce the oscillation pressure (Graham, 1978). The level of pneumatization is related to the genetic and auditory factors and also depends on the size of the skull and height of the people (Stern, 1950; Graham, 1978).

The CBCT technique has a wide application in dentistry, including pre-implantation planning, third molar imaging, Temporomandibular Joint (TMJ), evaluation and orthodontic treatment planning. It is also used to evaluate endodontic problems, periodontal diseases, caries and assessment of maxillary sinuses and air ways (Ziegler et al., 2005; Demirel et al., 2014).

In a study conducted by Oguzhan Demirel et al. in 2014 to assess mastoidal pneumatization and its relationship with age and gender using the CBCT technique, it was concluded that there is no clear relationship between pneumatization and age and gender (Demirel et al., 2014). In a study performed by Khalid Hindi et al., in 2014 to evaluate the pneumatization of paranasal sinuses and other parts of temporal bone, including mastoid air sinuses, it was concluded that pre-surgery CT scan of temporal bone is effective on evaluation of anatomical landmarks and the complexity of the surgery of the three-dimensional structure will be facilitated (Hindi et al., 2014).

Since in the previous studies, a vast age range has been studied and most of them were based on gender, and only CT technique was used for evaluation of mastoid air cells pneumatization, therefore, present study was conducted in order to investigate the pneumatization of mastoid air cells using the CBCT technique and comparing it to different age groups and separated from gender.

Materials and methods

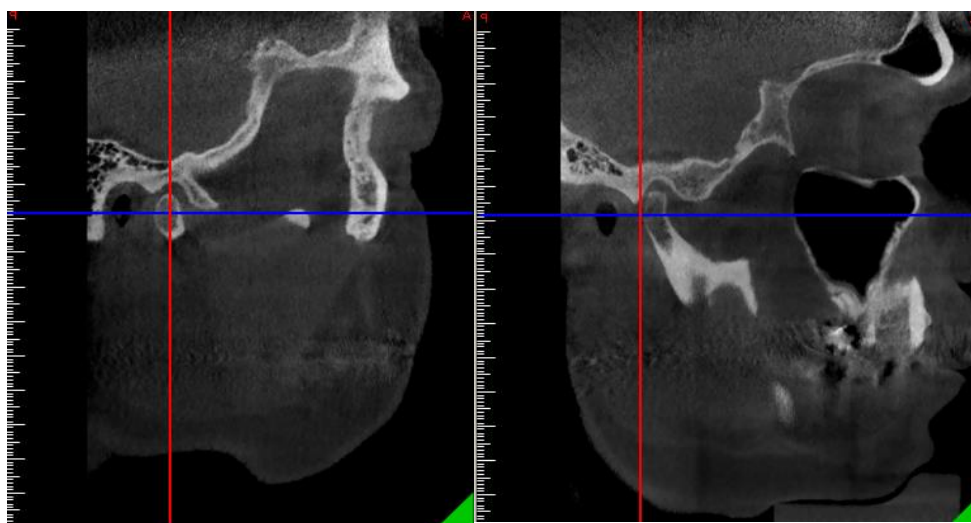
This is a kind of descriptive-analytic study carried out using CBCT stereotypes of Oral and Maxillofacial Radiology Faculty of Tabriz Dental School. For this study, a CBCT 200 (100 male, 100 female) patients who referred to the oral and maxillofacial radiology department of the faculty of dentistry have been studied, as the data have been provided by the specialist assistant under the supervision of the relevant supervisor. These images were evaluated by the student of Oral and maxillofacial radiology course.

The images were prepared using NewtomVG cone beam (Verona/Italy) in the Department of Maxillofacial Radiology, Faculty of Dentistry, Tabriz University of Medical Sciences. CBCT images were analyzed by a NNT software and monitor 19-inch LCD 190B (Philips, Eindhoven, Netherland) at a resolution of 1024-1280 by a detector and images were displayed in the semi-dark room. In this study, samples are taken in the axillary, coronal and sagittal sections.

Then, the degree of pneumatization of mastoid air cells in 20 CBCT images is determined by two oral, maxillofacial radiologists and the agreement between the two radiologists is determined using Kappa Cohen coefficient. Since the results indicated a significant agreement between the two radiologists, rest of the images was examined by a single radiologist and, at the end, the results were classified according to the classification system of Ibrahim, Alfaleh, as follows (Virapongse et al., 1985):

Grade 0 → pneumatization limited to process mastoid.

Grade 1 → pneumatization between mastoid processes and glenoid fossa.



Grade 2 → pneumatization between the deepest part of the glenoid fossa and the summit of the (articular eminence).

Grade 3 → pneumatization extends beyond the highest part of the articular eminence.

Figure 1. Images of zero and one grades on the right and left sides, respectively

Grades 2 and 3 are accepted as articular eminence pneumatization. After determining the degree of pneumatization, the age and gender of the person being photographed were recorded on the checklist.

Statistical data analysis

The results of the study have been presented using descriptive statistics (mean±standard deviation) using SPSS 20 software. The relationship between gender, age groups and pneumatation is analyzed by Chi-Square test. In this study, p-value less than 0.05 was considered to be significant.

Results

The results of the demographic characteristics of the patients indicated that 50% of the patients are female and the rest 50% are male. Also, 8 patients were in the age group of 10-20 years old, 56 people were in the age group of 21-30 years, 132 people were in the age group of 31-40 and 4 people were in the age group of 40-50 years (Table 1). In addition, evaluation of the mean age of patients showed that the average male and female age was 33.84 and 32.8 years, respectively, which according to t-test, there was no significant difference in mean age based on the gender.

Table 1. Frequency of patients based on gender and age group

| Total | Age group | | | | Frequency | |
|--------|-----------|--------|--------|--------|------------|--------|
| | >40 | 31-40 | 21-30 | ≤ 20 | | |
| 100 | 0 | 72 | 24 | 4 | Frequency | Female |
| 50.0% | 0 | 54.5% | 42.9% | 50.0% | percentage | |
| 100 | 4 | 60 | 32 | 4 | Frequency | Male |
| 50.0% | 100.0% | 45.5% | 57.1% | 50.0% | percentage | |
| 200 | 4 | 132 | 56 | 8 | Frequency | Total |
| 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | percentage | |

1. Comparison of pneumatization frequency of mastoid air cells based on gender:

The study of mastoid pneumatization grade of mastoid air cells showed that in women, 36% were grade 0, 44% were grade 1, 8% were grade 2 and 12% were grade 3. In men, 44.9% were zero degree 0, 24.5% were grade 1, 24.5% were grade 2 and 6.1% were grade 3 (Figure 1).

Table 2. Comparison of pneumatization frequency of mastoid air cells based on gender

| Grade | | Gender | | Total |
|-------|------------|--------|--------|--------|
| | | Male | Female | |
| | Frequency | 44 | 36 | 80 |
| 0 | Percentage | 44.9% | 36.0% | 40.4% |
| | Frequency | 24 | 44 | 68 |
| 1 | Percentage | 24.5% | 44.0% | 34.3% |
| | Frequency | 24 | 8 | 32 |
| 2 | Percentage | 24.5% | 8.0% | 16.2% |
| | Frequency | 6 | 12 | 18 |
| 3 | Percentage | 6.1% | 12.0% | 9.1% |
| | Frequency | 98 | 100 | 198 |
| Total | Percentage | 100.0% | 100.0% | 100.0% |

Pearson Chi-Square Value=16.64, p value=0.001

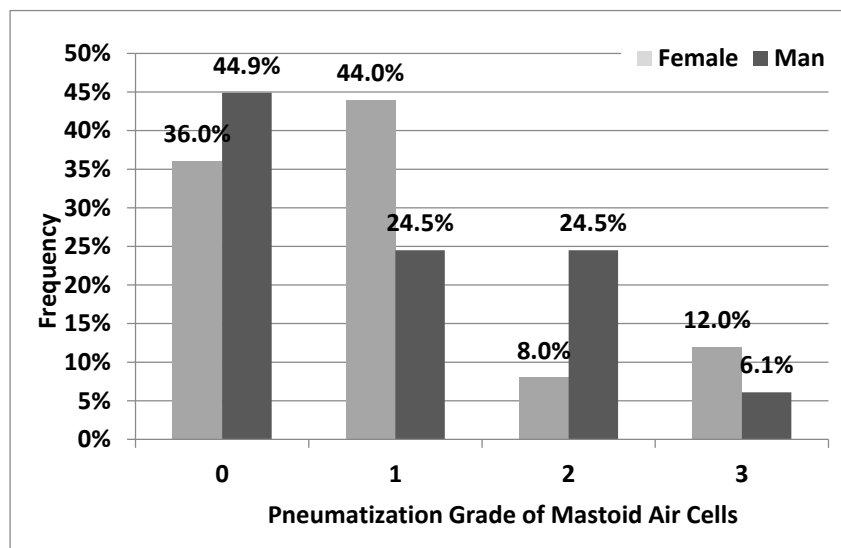


Diagram 1. Comparison of the frequency of pneumatization grade of mastoid air cells based on the gender

2. Determining the pneumatization grade of mastoid air cells using age-based CBCT technique

The study of mastoid air pneumatization shows that in the age group of 10-20 years, 25% were grade 0 and 75% were grade 1. Also, in the age group of 21-30 years, 48.1% were grade 0, 18.5% were grade 1, 33.3% were grade 2, whereas in the age group of 31-40 years, 36.4% were grade 0, 39.4% were grade 1, 10.6% were grade 2 and 13.6% were grade 3. Finally, in the age group of 41-50 years, 100% of the subjects were grade 0 (Figure 2). Chi-square test showed a significant difference in the frequency of pneumatization grade based on age groups.

Table 3. Comparison of pneumatization grade of mastoid air cells based on age groups

| Grade | Age group | | | | Total |
|-------|-----------|-------|-------|-------|-------|
| | 10-20 | 21-30 | 31-40 | 41-50 | |
| 2 | 2 | 26 | 48 | 4 | 80 |

| | | | | | |
|---|-------|--------|--------|--------|--------|
| 0 | 25.0% | 48.1% | 36.4% | 100.0% | 40.4% |
| | 6 | 10 | 52 | | 68 |
| 1 | 75.0% | 18.5% | 39.4% | | 34.3% |
| | | 18 | 14 | | 32 |
| 2 | | 33.3% | 10.6% | | 16.2% |
| | | | 18 | | 18 |
| 3 | | | 13.6% | | 9.1% |
| | | 54 | 132 | 4 | 198 |
| Total | | 100.0% | 100.0% | 100.0% | 100.0% |
| Pearson Chi-Square Value=16.64, P-value=0.001 | | | | | |

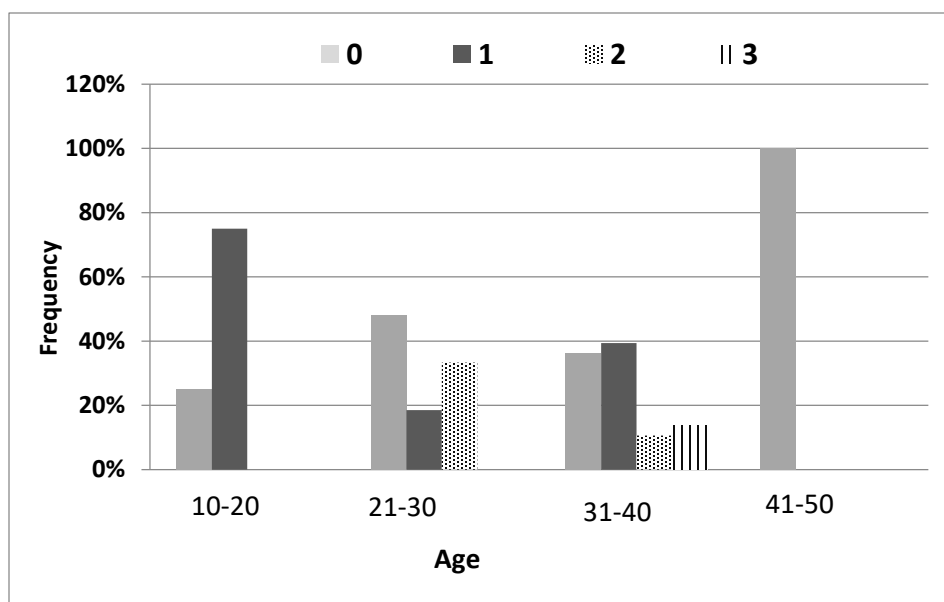


Diagram 2. Comparison of frequency of mastoid air cell pneumatization grade based on age groups

3. Determination of pneumatization grade of mastoid air cell using CBCT technique based on mastoid bone side:

The study of pneumatization grade of mastoid air cell shows that at the right side, 39.4% were grade 0, 36.4% were grade 1, 16.2% were grade 2, and 8.1% were the grade 3. While at the left 41.4% were grade 0, 32.3% were grade 1, 16.2% were grade 2 and 10.1% percent were grade 3. Also, the Chi-square test did not show a significant difference in the frequency of pneumatization grade based on the side of mastoid bone.

Table 4. Comparison of the frequency of pneumatization grade of mastoid air cell based on mastoid bone side

| Grade | | Side | | Total |
|-------|------------|-------|-------|-------|
| | | Right | Left | |
| 0 | Frequency | 39 | 41 | 80 |
| | Percentage | 39.4% | 41.4% | 40.4% |
| 1 | Frequency | 36 | 32 | 68 |
| | Percentage | 36.4% | 32.3% | 34.3% |
| 2 | Frequency | 16 | 16 | 32 |
| | Percentage | 16.2% | 16.2% | 16.2% |

| | | | | |
|---|------------|--------|--------|--------|
| | Frequency | 8 | 10 | 18 |
| 3 | Percentage | 8.1% | 10.1% | 9.1% |
| | Frequency | 99 | 99 | 198 |
| Total | Percentage | 100.0% | 100.0% | 100.0% |
| Pearson Chi-Square Value=16.64, p value=0.001 | | | | |

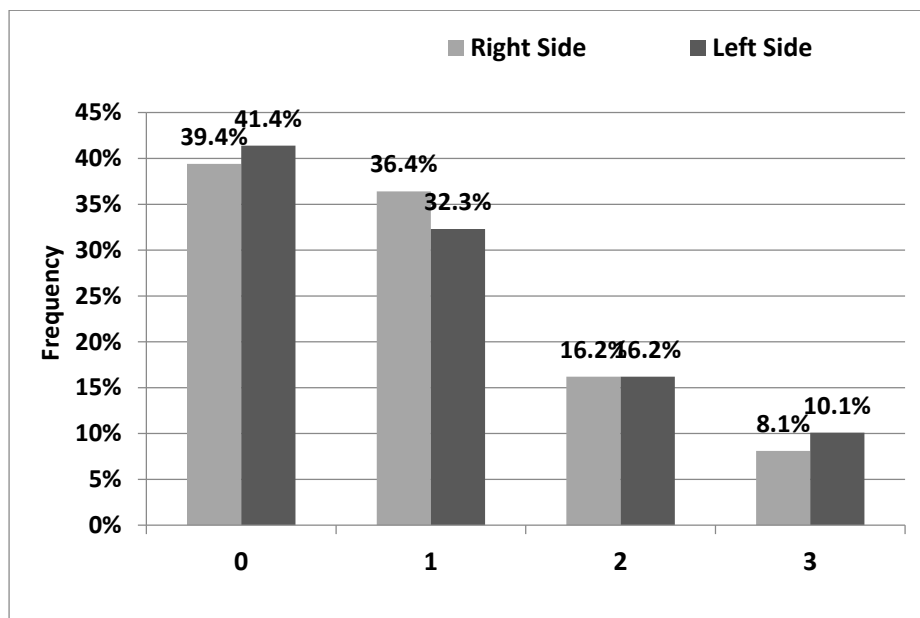


Diagram 3. Comparison of the frequency of pneumatization grade of mastoid air cell based on mastoid bone side:

Discussions

The formation of air cells is caused by the formation of bone cavities resulting from the normal activity of the periosteum. The primary bone marrow containing these cavities is differentiated into mesenchymal tissue, after the folding of the mucus epithelial membrane into the inside (invagination), a thin linear epithelial membrane remains as the result of atrophy, as the air cells would enlarge by retreat of this linear membrane and breakdown of sub-epithelial bone (Virapongse et al., 1985).

Temporal components of the temporomandibular joint are articular cavity and articular eminence, which form a small part of the middle cranial fossa, and the mastoid process pneumatization extends to these regions (Al-Faleh et al., 2005).

Since the axial, sagittal, coronal and cross-sectional images taken by CBCT technique cause no superimpositions in this technique, and also CBCT provides accurate information about the temporomandibular bone morphology (Demirel et al., 2014), so in this study by using CBCTs stereotype, we investigated the pneumatization of mastoid air cells.

In present study, CBCT stereotypes of male and female patients referring to Oral and Maxillofacial Radiology Department of Tabriz Dental School have been evaluated. The mean age in female patients was 33.8 and in male patients was 32.8 years, as no significant difference was observed in the mean age.

Also, in this study, the degree of pneumatization significantly differed by gender. As the first-degree frequency in women (44%) was higher than that of men (24.5%). Also the grade 2 frequency in men (24.5%) was higher than in women (8%). The frequency of grade 0 pneumatization was higher than other grades in both women (36%) and men (44.9%).

Yegin et al., reported that there is a statistically significant difference in the grade of pneumatization of mastoid air cells in men and women, which was consistent with the result of this study (Yegin et al., 2016). Lee et al., Stated that there is a statistically significant difference in the grade of mastoid air cell pneumatization in men and women. The result of their study was consistent our study (Lee et al., 2005). But the interesting point in the study of Ibrahim and Alfaleh is that, contrary to the present study, wherethe zero-degree pneumatization had the highest frequency in both males and females gender,in the study conducted by these researchers, the grade 1 pneumatization has the highest frequency (Al-Faleh et al., 2005). Oguzhan Demirel et al., Reported that there is no definite relationship between pneumatization and gender of persons (Demirel et al., 2014). According to the results of aboveand present study, effect of gender on the amount of mastoid pneumatization could be analyzed in such a way that the skull of women holds mastoid process as small as adolescence, while the larger mastoid size in men could be related to a stronger muscular structure, as the dissonances and irregularities observed in men's mastoid processes in comparison with women also confirms this issue to some extent, (Amin W et al., 2015). In addition, one of the reasons for the difference observed in the results of the present study with some previous studies could be attributed to the mean age of patients in various studies. Asduring comparing the frequency of different studies, theequalityof the mean age should be considered. In this study, almost young people have been investigated, which can be a reason for the high frequency of grade 0. Also, in the present study, there was a significant difference in the frequency of pneumatization grade based on age groups. As grades 2 and 3 did not exist in age groups of 10-20 and 41-50 years old. Also the grade 3 pneumatization was observed only in the age group of 31-40 years. Also, the findings of this study showed that the frequency of pneumatization grade on the side of mastoid bone did not show a significant difference. While Lee et al. (2005) showed that there is a significant difference between the right and left sides (Lee et al., 2005). In 2005, Karakas et al., conducted a study to investigate the morphometric parameters of paranasal sinuses and mastoid air cells using computer tomography. Results showed that there is a positive correlation between right and left structures of paranasal sinuses and mastoid air cells on the same side (Kavakli, 2005). These results are not consistent with the results of this study, which could be attributed to the difference in CT imaging technique of two above studies with the imaging technique weused here (CBCT).

Conclusion

The results of this study showed that the pneumatization grade of mastoid air cells has a significant difference based on gender and age groups. The CBCT technique is an appropriate method for evaluating the pneumatization of mastoid air cells and can be used in various dentistry disciplines as well as a prognosis for the onset of a middle ear infection.

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