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Original Article

Dental students' levels of understanding normal panoramic anatomy

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KEYWORDS

Panoramic radiograph;
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Abstract *Background/purpose:* In dentistry, panoramic radiography is an important examination technique. The Faculty of Dentistry at Tokushima University educates students about panoramic radiographic anatomical landmarks. The purpose of this study was to investigate differences in the understanding of each panoramic anatomical landmark among students.

Materials and methods: This study analyzed the results of 40 fifth- and 79 sixth-year faculty students who had taken a written examination to clarify their knowledge of anatomical landmarks in 28 panoramic radiographic regions. Anatomical landmarks were classified into 3 categories: <bone structure>, <soft tissue/air layer>, and <ghost images> to compare correct answer rates.

Results: The mean overall correct answer rate by the 119 students for the 28 regions was 53%. The rate did not vary between the 2 academic years. On comparison of the 3 categories, significant differences were only observed between <bone structure> and <soft tissue/air layer>, as the values for the latter were lower. Among the anatomical landmarks, the rates for the condylar head, hyoid bone, panoramic innominate line, styloid process, and nasopalatine line were higher, and those for ghost images of the contralateral nasopalatine line, the cervical vertebrae, mandibular foramen, mastoid air cell, and posterior pharyngeal wall were lower. The values for <soft tissue/air layer>, such as the dorsum of tongue, middle and inferior nasal conche, and middle and inferior nasal meatuses, were also lower.

Conclusion: These results indicate the necessity of improving educational approaches for regions with lower rates of correct answers.

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Introduction

Panoramic radiography is an important imaging technique in dentistry. In Japan, the rate of using panoramic imaging devices is high among dental clinics. For accurate diagnosis based on panoramic radiography, not only high-level anatomical knowledge, but also an understanding of the principles of panoramic imaging are indispensable. To date, some educational books illustrating normal anatomical structures in panoramic radiography have been published.¹⁻⁶

The Faculty of Dentistry at Tokushima University provides continuous education for students to acquire knowledge of panoramic radiographic anatomical structures. During the 6-year dental education, students learn through lectures and basic training in the fourth year, clinical preliminary training in the fifth year, and through clinical training in the sixth year. Each lecture lasts for 60 min. During basic training, students trace panoramic radiographs. During clinical preliminary training, they are divided into groups with 6–8 members to explain normal anatomical structures using tracings of panoramic images. Similarly, during clinical training, each student group explains the abnormal panoramic radiographic findings.

When observing these anatomical structures, it may be difficult for students to understand and memorize some regions. However, there have been no studies examining such difficulties based on the region. Therefore, we conducted an examination for fifth-year students who had completed clinical preliminary training and sixth year students who had completed clinical training to clarify their knowledge of panoramic radiographic anatomical landmarks, as well as landmarks that are less accurately understood by students.

Materials and methods

An examination on panoramic radiographic anatomical landmarks was conducted for fifth- and sixth-year students of the Faculty of Dentistry at Tokushima University, and their results were analyzed.

The examinees were sixth-year students in FY2015 and 2016, and fifth-year students in FY2017. They were notified of the examination 1 week in advance.

In this written examination, tracings of panoramic radiographs were presented with arrows to answer boxes for the anatomical names of the 28 indicated regions. An examination paper on which tracings and answer boxes were printed was distributed to each examinee. The duration of the examination was 30 min. Fig. 1 shows the tracings and 28 regions used for the examination.

The students' examination results were analyzed to compare correct answer rates between the 2 academic years, sexes, and among the 28 regions. Furthermore, the 28 regions were classified into 3 categories: <bone structure>, <soft tissue/air layer>, and <ghost images> to compare correct answer rates. The significance level was set at 5%, and the non-parametric Wilcoxon test was used to compare paired data.

Results

Forty fifth- and 79 (32 in 2015 and 47 in 2016) sixth-year students took the examination. There were 70 males and 49 females. The overall correct answer rate for the 28 regions was 53.04% (standard deviation: 18.84) among fifth-year and 52.98% (13.85) among sixth-year students, demonstrating no significant difference ($P > 0.05$). The mean overall correct answer rate between the 2 academic years

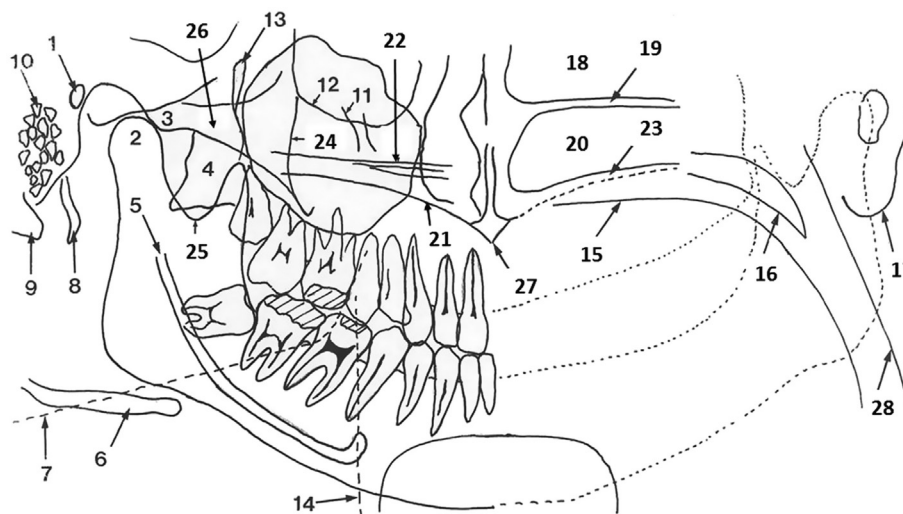


Fig. 1 Tracings of panoramic radiographs used for the examination. The arrows in the figure indicate the following anatomical landmarks: 1: external acoustic foramen, 2: condylar head, 3: articular eminence, 4: lateral plate of sphenoid, 5: mandibular foramen, 6: hyoid bone, 7: ghost image of contralateral mandible, 8: styloid process, 9: cervical vertebrae, 10: mastoid air cell, 11: infra-orbital canal, 12: infraorbital border, 13: pterygopalatine fossa, 14: ghost image of cervical vertebrae, 15: dorsum of tongue, 16: soft palate, 17: ear lobe, 18: middle nasal concha, 19: middle nasal meatus, 20: inferior nasal concha, 21: nasopalatine line, 22: ghost image of contralateral nasopalatine line, 23: inferior nasal meatus, 24: panoramic innominate line, 25: mandibular notch, 26: zygomatic arch, 27: anterior nasal spine, 28: posterior pharyngeal wall.

was 53.00% (23.5). Male and female rates were 50.86 and 56.07%, respectively; the latter was higher, but the difference was not significant ($P > 0.05$).

Table 1 shows the correct answer rates for the categorized 28 regions. The values were similar between the 2 academic years. The rates for the condylar head (97%) and hyoid bone (97%) were the highest, followed by those for the panoramic innominate line (80%), styloid process (79%), and nasopalatine line (79%).

In contrast, the rate for ghost images of the contralateral nasopalatine line (3%) was the lowest, followed by those for the cervical vertebrae (7%), mandibular foramen (17%), mastoid air cell (27%), and posterior pharyngeal wall (29%). The values for regions classified into <soft tissue/air layer>, such as the dorsum of tongue (45%), middle (41%) and inferior (45%) nasal conche, and middle (46%) and inferior (50%) nasal meatuses, were also slightly low. On comparison of the 3 categories, significant differences were only observed between <bone structure> and <soft tissue/air layer> ($P = 0.036$), as the correct answer rate for the latter was lower. There were no significant differences in the rates between <bone structure> or <soft tissue/air layer> and <ghost images>.

Table 1 Correct answer rates.

Anatomical Landmark number	Percentage of correct answer		
	5th year student	6th year student	Total
1	53	44	47
2	100	96	97
3	60	65	63
4	50	57	55
5	18	16	17
6	90	100	97
7	53	49	50
8	83	77	79
9	10	5	7
10	30	25	27
11	73	38	50
12	40	41	40
13	60	62	61
14	33	43	40
15	40	48	45
16	43	56	51
17	73	68	70
18	45	39	41
19	48	46	46
20	45	44	45
21	73	82	79
22	10	0	3
23	45	52	50
24	75	82	80
25	68	80	76
26	63	71	68
27	80	68	72
28	30	28	29

Correct answer rates for the categorized anatomical landmarks, overall correct answer rates, and those for the 2 academic years. Correct answer rates were converted into integrals by rounding off numbers after the decimal point.

Discussion

In oral and maxillofacial radiology, an appropriate understanding of panoramic radiographic anatomical structures is essential for accurate diagnosis.³ According to a study by Shintaku et al.,⁷ educating students on diagnostic criteria using anatomical landmarks on panoramic images of osteoporosis resulted in high agreement with the diagnostic results of radiologists and students. An understanding of anatomical landmarks is necessary to enhance diagnostic ability. Although a number of books explaining these landmarks are available,^{1–6} there have been no reports analyzing the level of understanding by students. Razmus et al.⁸ assessed the knowledge of graduating American dental students about panoramic images. The report also included an evaluation of knowledge about anatomical landmarks, but it did not mention the degree of comprehension of each anatomical structure. We conducted an examination on panoramic radiographic anatomical landmarks for students in 2 different academic years, and analyzed their results to clarify landmarks that are easy or difficult for students to understand and memorize.

For the examination, tracings, rather than panoramic radiographs themselves, were used. Considering the difficulty of providing each examinee with an optimal environment for observation, and as hard and soft tissues or other structures complicatedly overlap, they were presented in subtle shades on panoramic radiographs. Furthermore, tracings illustrated with lines more clearly show regions compared with radiographic images. Another reason for this method is that students of our faculty trace panoramic radiographs during training-based education. On the other hand, the tracings lack the radiographic density information found in the original radiograph. Bone, soft tissue, and air layers have obvious density differences, but not in trace images. In order to evaluate the students' comprehension level, a technique to express density in the figure may be necessary.

Similarly, for the examination, these 28 panoramic radiographic regions were selected because they are likely to be more markedly influenced by oral and maxillofacial diseases. In addition to hard tissue, soft tissue, the air layer, and ghost images created through panoramic radiography were also included, considering the possibility of these leading to inaccurate image diagnosis. From the candidate regions, 28 were selected to adjust the duration of the examination to approximately 30 min.

As the examination was conducted 2–3 months after clinical training for both fifth- and sixth-year students, they likely took it under similar conditions. On analysis, there were no significant differences in the correct answer rates between them, suggesting that their knowledge or understanding of panoramic radiographic anatomical structures is not enhanced between the fifth and sixth year. The factor more closely associated than the academic year may have been differences between landmarks that are more or less carefully observed by students, as the former were less difficult to understand.

The correct answer rate markedly varied from several to nearly 100% among the 28 regions, possibly due to the previously-mentioned differences between landmarks that

are more or less carefully observed by students. Based on this, images of <soft tissue/air layer> are likely to be paid less attention than those of <bone structure>, as there were significant differences in the correct answer rate between these categories. Ghost images, which are derived from an imaging mechanism specific to panoramic radiography and occasionally interfere with diagnosis, may also be less carefully observed by students. Indeed, the correct answer rate was low.

On examination of anatomical landmarks with lower correct answer rates, the same incorrect answers were frequently observed. For example, the overall correct answer rate for the mandibular foramen was 17%, and "mandibular canal" was the most frequently observed incorrect answer, indicating the necessity of improving figures used for this question, as the examinees likely had difficulty in accurately understanding the relevant region. Frequent incorrect answers related to <soft tissue/air layer> included "middle nasal concha" instead of "middle nasal meatus" and "inferior nasal concha" instead of "inferior nasal meatus", or vice versa. This suggests that many students misunderstand the positional relationship between soft tissue and the air layer.

This study clarified the knowledge of panoramic radiographic anatomical landmarks held by dental students. As a future challenge, it may be necessary to provide education focused on landmarks with lower correct answer rates, particularly on soft tissue and the air layer. As the correct answer rate did not vary between fifth- and sixth-year students, conventional educational approaches should also be reviewed. In this study, we evaluated their knowledge two to three months after education, but it may be necessary to ascertain the change in knowledge, for example just before and after the sixth-year education, and even a few months later. Repeated learning is important for items that are difficult for students to memorize. For sixth-year students in particular, education should be focused on areas that are less accurately understood. Tadinada et al.⁹ examined the visibility of anatomical landmarks on tablets displaying 466 panoramic radiograph images, and found that the same results were obtained as with conventional LCD monitors. For some landmarks, the tablets provided better visibility for anatomical landmarks. This demonstrates that tablets can be used as educational tools for panoramic anatomical landmarks. It is necessary to continue studying educational methods based on advances in hardware and software.

The results of the examination for fifth- and sixth-year students of the Faculty of Dentistry to clarify their

knowledge of panoramic radiographic anatomical landmarks demonstrated no differences in the correct answer rate between the 2 academic years. After classifying the 28 regions into 3 categories, <bone structure>, <soft tissue/air layer>, and <ghost images>, significant differences in the correct answer rate were only observed between <bone structure> and <soft tissue/air layer>. Rates for <bone structure>, such as the condylar head, hyoid bone, panoramic innominate line, styloid process, and nasopalatine line, were slightly higher. In contrast, those for <soft tissue/air layer>, including ghost images of the contralateral nasopalatine line, the cervical vertebrae, posterior pharyngeal wall, dorsum of tongue, middle and inferior nasal concha, and middle and inferior nasal meatuses, were slightly lower. These results indicate the necessity of providing education focused on landmarks with lower rates for correct answers.

Conflicts of interest

There are no conflicts of interest to declare.

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