J Forensic Sci, July 2004, Vol. 49, No. 4
Paper ID JFS2003339
Available online at: www.astm.org

Sang-Seob Lee,[1,4] *D.D.S.; Jong-Hoon Choi,*[1,2,4] *Ph.D.; Chang-Lyuk Yoon,*[3,4] *Ph.D.; Chong-Youl Kim,*[1,2,4] *Ph.D.; and Kyoung-Jin Shin,*[2,4] *Ph.D.*

The Diversity of Dental Patterns in the Orthopantomography and Its Significance in Human Identification

ABSTRACT: The primary aim of this study was to evaluate the utility of orthopantomography for human identification. Three hundred orthopantomograms were randomly selected from those stored at Dental Hospital of Yonsei University in Seoul. Dental patterns observed in the orthopantomograms were converted into eight codes and their diversity was calculated. The diversity of dental patterns in the orthopantomogram data was 99.92% for full dentition and the diversity of mandible (99.28%) was slightly higher value than that of maxilla (98.22%). In the case of molars and premolars in both jaws, the diversity values ranged from 92.13% to 96.04%. It was founded that orthopantomography is a valuable means of personal identification not only based on full dentition but also when only the posterior teeth are available. The present study indicates that orthopantomography is excellent means of forensic identification.

KEYWORDS: forensic science, orthopantomography, human identification, diversity, dental pattern, forensic odontology

Investigations of jaws and teeth, the most well preserved parts of the human body, have been proven a basic and valuable method in human identification (1,2). The comparison of antemortem and postmortem dental characteristics is a commonly applied method to perform personal identification. Typical antemortem dental records may include radiographs, dental charts (odontograms), both intraoral and/or extraoral photographs, dental casts, and notes (3). Dental radiographs are certainly one of the most desirable pieces of antemortem evidence because of their highly objective nature as compared with other records.

Of the many kinds of dental radiography, orthopantomography is a broadly applied standard method in dentistry and is used for initial examinations for odontologic issues in treatment. It provides a complete view of the teeth and both jaws in one image (4). Gustafson was the first to use orthopantomography in forensic practice for the purpose of identification (5), according to theory proposed by Paatero (6). Rocca et al., who considered orthopantomograms to be the most important antemortem source of information outside the written treatment records (7). Some case reports of dental comparisons involving orthopantomograms have been reported (1,4, 7–12). In particular, Chesne et al. reported ways of producing postmortem orthopantomograms that provide highly detailed information (13).

Adams reported upon the diversity of adult dental patterns using empirical observations of large reference data sets (3,14). These reports were specifically non-radiographic dental comparisons, such as treatment notes or odontograms. Compared with dental charts, which may be subjective, dental radiographs are more objective and show relatively less errors. In addition, since postmortem investigators can evaluate antemortem and postmortem radiographs simultaneously, positive identification can be obtained more easily than that of dental charts which carry the risk of errors among the different investigators. For these reasons, there is a clear need for the diversity of dental patterns in orthopantomograms to be explored in more detail.

Materials and Method

The 300 orthopantomograms were randomly selected from those stored at Dental Hospital of Yonsei University in Seoul. Dental patterns were classified into eight types which are commonly observed in dental radiography and converted into a consistent set of codes by a well-trained forensic odontologist. Table 1 presents dental patterns and codes. In the present study, only permanent dentition was considered. The diversity of dental patterns was calculated for full dentition, maxilla, mandible and the sextants, respectively (3,15).

Results

Two hundred eighty-two different dental patterns were observed in the full dentition data set (Table 2). In the case of the maxilla, 210 different dental patterns were observed and in the case of the mandible, the number of different patterns was 211. The number of different dental patterns of the 4 posterior tooth areas ranged from 85 to 106 and showed no difference between the left and right maxilla and mandible. However, in the case of the anterior tooth area the number of different dental patterns for the maxilla was 73 and for the mandible was 28. This was somewhat less than that of the posterior tooth area. The number of individual dental patterns was found to be in proportion to that of different dental patterns as

[1] Department of Oral Diagnosis and Oral Medicine, College of Dentistry, Yonsei University, Seoul, Korea.
[2] Department of Forensic Medicine, College of Medicine, Yonsei University, Seoul, Korea.
[3] Department of Oral Medicine and Forensic Odontology, College of Dentistry, Chosun University, Gwangju, Korea.
[4] Human Identification Research Institute, Yonsei University, Seoul, Korea.
Received 12 Oct. 2003; and in revised form 16 Jan. and 14 Feb. 2004; accepted 14 Feb. 2004; published 26 May 2004.

TABLE 1—*Classified dental patterns seen in orthopantomograms and corresponding codes.*

Code	Description
V (Virgin tooth)	No evidence of dental disease, treatment or anatomical abnormality
X (Missing tooth)	Extracted or congenital missing tooth
I (Impacted tooth)	Unerupted or impacted tooth
D (Defect)	Defect by dental caries, tooth fracture or fallen out fillings
R (Residual root)	Remained root due to severe dental caries
T (Root canal treatment)	Root canal filled tooth by endodontic treatment
F (Filling)	Filled tooth
P (Prosthesis)	Tooth with crowns

TABLE 2—*The number of dental patterns for full dentition and for sextants (n = 300).*

Area	Number of Different Dental Patterns	Number of Individual Dental Patterns*
Full dentition	282	274
Maxilla	210	192
Mandible	211	181
Upper right	103	78
Upper anterior	73	65
Upper left	95	66
Lower left	85	64
Lower anterior	28	25
Lower right	106	74

* Individual dental pattern is defined as the dental pattern only once observed in this study.

TABLE 3—*The most commonly observed dental patterns in orthopantograms (n = 300).*

Area	Dental Pattern	Number	Percent
Full dentition	IVVVVVVVVVVVVVVI	6	2.0
Maxilla	XVVVVVVVVVVVVVVX	33	11.0
Mandible	IVVVVVVVVVVVVVVI	15	5.0
Upper right	XVVVV	66	22.0
Upper anterior	VVVVVV	219	73.0
Upper left	VVVVX	72	24.0
Lower left	XVVVV	33	11.0
Lower anterior	VVVVVV	270	90.0
Lower right	VVVVV	30	10.0

shown in Table 2. The most common dental pattern observed in full dentition was created by the 28 virgin teeth and 4 impacted third molars and its frequency was merely 2.0%. On the other hand, in the upper and lower anterior tooth area (incisors and canines), the dental pattern created by 6 virgin teeth was most common and its frequency was 73.0% and 90.0% for the upper and lower anterior tooth area, respectively (Table 3).

The diversity of dental patterns for full dentition was 99.92% and in the case of maxilla alone the diversity was 98.22% and for mandible was 99.28%. There was no significant difference between the diversity of maxilla and mandible. The diversity of molars and premolars was 92.13, 92.43, 95.65, 96.04% for the upper left and right teeth, and the lower left and right teeth, respectively. The diversity of the anterior tooth area was 46.75% in maxilla and 19.02% in mandible (Table 4).

TABLE 4—*Diversity of dental patterns in orthopantomograms.*

Area	Diversity (%)
Full dentition	99.92
Maxilla	98.22
Mandible	99.28
Upper right	92.43
Upper anterior	46.75
Upper left	92.13
Lower left	95.65
Lower anterior	19.02
Lower right	96.04

Discussion

Orthopantomographs provide a complete view of both jaws and teeth in one image and offer advantages in terms of dental record keeping. The availability of orthopantomograms and their conveying details have established this dental record as a valuable aid in comparing antemortem and postmortem dental characteristics. In addition, it is taken routinely on all ages in dental clinics. In this study, the diversity of dental patterns in orthopantomogram was evaluated in application to human identification.

As shown in Table 4, the diversity of dental patterns for full dentition was 99.92% and separately for maxilla and mandible were 98.22 and 99.28%. In the case of molars and premolars, the diversity was 92.13–96.04%. These high diversity values imply the sufficient power of personal identification not only based on full dentition but also when only molars and premolars are available. However, it is necessary to keep in mind the fact that the diversity created by 4 virgin molars and premolars with an impacted or missing third molar was 22.0–24.0% for maxilla and 10.0–11.0% for mandible (Table 3).

The diversity of the anterior tooth area had lower value compared to full dentition or for molars and premolars (Table 4). Reasons for this may be the anterior teeth have smooth surfaces, therefore, the rate of dental caries is lower than for the posterior teeth which have complex anatomical features. In addition, the self-cleansing effect of saliva also plays an important role in producing a lowering the rate of dental caries for the anterior teeth. Since almost all of dental patterns are created from dental treatments for dental caries, the dental diversity in anterior tooth area is less. It was observed in this study that the percentage dental pattern created by 6 virgin teeth in anterior teeth were 73.0% in maxilla and 90.0% in mandible. Therefore, human identification by using only radiographs of incisors and canines was founded to be difficult. From this, human identification based on incisors and canines may rely on malocclusion such as rotation, crowding and spacing and/or developmental anomalies for example peg lateralis etc. These features may be observed in clinical examinations and antemortem photographs.

Generally, the dental characteristics used in human identification are obtained from dental charts and radiographs. Compared with radiographic images, dental charts may carry the risk of errors from subjective recordings of dentists. On the other hand, antemortem and postmortem radiographic images can be compared simultaneously by one investigator, and orthopantomography allows information to be transferred in a form not subject to linguistic barriers (16). In this context, our research based on relatively objective material, dental patterns shown in the orthopantomography would be considered to be valuable.

The results of this research show that the diversity of dental patterns in orthopantomograms is very high. Dental patterns in the orthopantomography are valuable in human identification not only

in the presence of whole teeth, but also in the presence of only the posterior teeth. The use of orthopantomography is practically applicable for the identification of victims of mass disasters as well as wars.

Acknowledgments

The authors wish to thank Il-Gu Lee and Jang-Ho Lee at the College of Dentistry, Yonsei University, for providing assistance during all phases of this research.

References

1. Brkic H, Strinovic D, Kubat M, Petrovecki V. Odontological identification of human remains from mass graves in Croatia. Int J Legal Med [PubMed] 2000;114:19–22.
2. Sopher IM . Forensic dentistry. Springfield: Charles C Thomas, 1976.
3. Adams BJ. The diversity of adult dental patterns in the united states and the implication for personal identification. J Forensic Sci 2003;48:497– [PubMed] 503.
4. Happonen RP, Laaksonen H, Wallin A, Tammisalo T, Stimson PG. Use of orthopantomographs in forensic identification. Am J Forensic Med [PubMed] Pathol 1991;12:59–63.
5. Gustafson G. Forensic odontology. London: Staple Press, 1966.
6. Paatero YV. Pantomography in theory and use. Acta Radiol 1954;41:321– [PubMed] 35.
7. Rocca A, Cianfarani F, Ansaldi L, Lenziani E, Paoli JR. Identification par le schema dentaire: difficulties et reflexions a propos d'un cas. J Med Leg Droit Med 1994;37:387–94.
8. Pashinian GA, Ayub F. The use of odontograms and panoramic roentgenography in personal identification. Sud Med Ekspert 1992;35:23–4. [PubMed]
9. Solheim T, Lorentsen M, Sundnes PK, Bang G, Bremnes L. The "Scandinavian Star" ferry disaster 1990-a challenge to forensic odontology. Int J Legal Med 1992;104:339–45. [PubMed]
10. Andersen L, Juhl M, Solheim T, Borrman H. Odontological identification of fire victims-potentialities and limitations. Int J Legal Med 1995;107:229–34. [PubMed]
11. Lessig R. Orthopantomogramme—ein objectives Hilfsmittel in der forensisch-stomatologischen Praxis. Newsletter AKFOS 1996;3:29–32.
12. Soomer H, Ranta H, Penttila A. Identification of victims from the M/S Estonia. Int J Legal Med 2001;114:259–62. [PubMed]
13. Du Chesne A, Benthaus S, Teige K, Brinkmann B. Post-mortem orthopantomography—an aid in screening for identification purposes. Int J Legal Med 2000;113:63–9. [PubMed]
14. Adams BJ. Establishing personal identification based on specific patterns of missing, filled, and unrestored teeth. J Forensic Sci 2003;48:487– [PubMed] 96.
15. Jones DA. Blood samples: probability of discrimination. J Forensic Sci Soc 1972;12:355–9. [PubMed]
16. Borrman H, Dahlbom U, Loyola E, Rene N. Quality evaluation of 10 years patient records in forensic odontology. Int J Legal Med 1995;108: [PubMed] 100–4.

Additional information and reprint requests:
Prof. Kyoung-Jin Shin, D.D.S., Ph.D.
Department of Forensic Medicine
College of Medicine
Yonsei University
134 Shinchon-dong, Seodaemun-gu
Seoul 120-752, Korea
E-mail: kjshin@yumc.yonsei.ac.kr