

## ADVANTAGES OF THE DIGITAL X-RAY SYSTEM IN DENTAL IDENTIFICATION OF PERSONS WITH REFERENCE TO TWO MURDER CASES

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### ABSTRACT

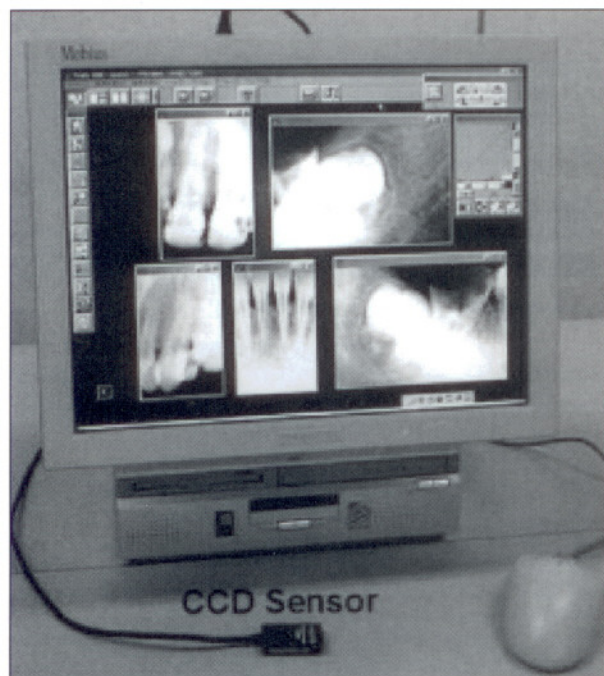
Direct digital X-ray technology was applied to dental identification of victims in two murder cases using the Compuray system. In both cases the digital radiography proved to be simple to use, quick and effective, allowing superimposition, enlargement and transportability to a mortuary. These are the first reported uses of the technology in Japan and further development promises the transmittability of data and images electronically to remote locations, further enhancing its usefulness. Comparing the skull with the dental ante-mortem X-ray films and records of a specific person who was reported "missing", we found many identical points between the two, especially in regard to the X-ray findings with the Compuray. In both cases we obtained a large number of X-ray images in a remarkably short time and this was very useful for identification by means of the teeth. (*J Forensic Odontostomatol* 2001;19:22-5)

**Key words :** Person identification, direct digital X-ray system, forensic odontology

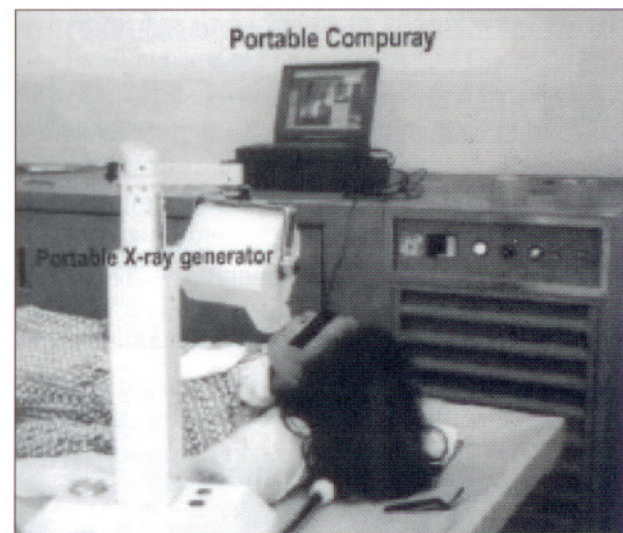
### INTRODUCTION

It is well known that dental evidence plays a very important role in the identification of bodies,<sup>1-7</sup> and of the various types of dental evidence, X-ray films are considered the most reliable and valid.<sup>2,4</sup> In

recent years digital X-ray photography techniques have been developed and applied in the fields of clinical dentistry<sup>8-10</sup> and forensic science<sup>11,12</sup> and in the latter a Compuray\* was used to identify victims in two murder cases (Fig. 1). In this paper we report on the usefulness of the direct digital X-ray system for person identification in two further cases of homicide.



**Fig.1:** The direct digital X-ray system (Compuray). A number of images are displayed at the same time



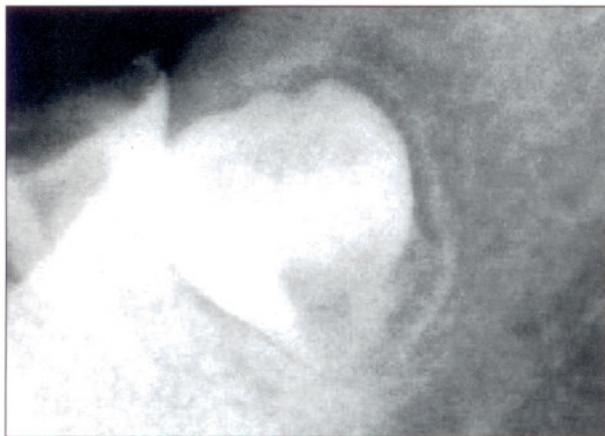
**Fig.2:** Scene of dental identification using the portable Compuray in Case 1.

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## CASE REPORTS

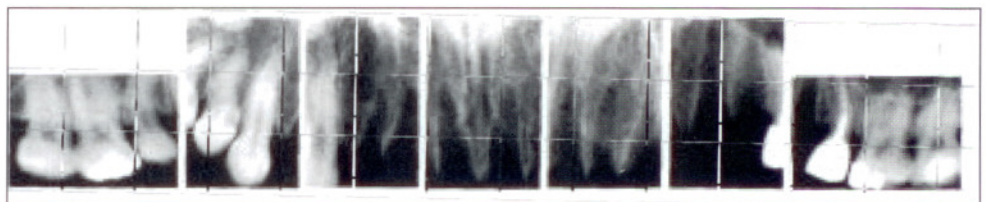
### Case 1

On 14 September 1997, the body of a deceased female was found on a path in Chiba Prefecture. At autopsy the cause of death was determined to be asphyxia by strangulation and although the body and clothes were intact and the post-mortem interval was estimated to be only a few hours, there was insufficient information for positive identification and the Chiba Prefectural Police Headquarters requested a dental examination to assist with identification. The examination was carried out immediately and the radiography was performed with a portable Compuray in the mortuary (Fig. 2).



**Fig.3:** Digital X-ray image of third molar showing a root that has not yet calcified

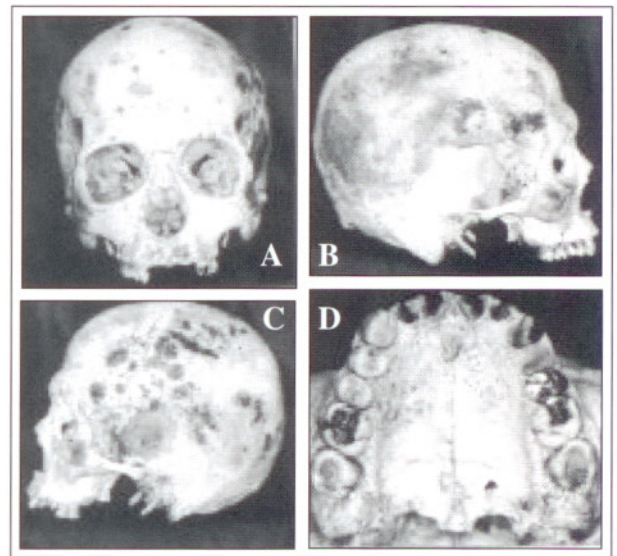
We obtained over 20 digital images of different parts of the remains from various angles (exposure dose: 4 - 6  $\mu\text{C}/\text{kg}$ ) (Fig. 1), all within a time span of five to six minutes. The findings were observed in detail and the deceased person's age estimated to be  $17 \pm 1$  years taking into account the degree of calcification of the unerupted mandibular third molars, attrition in the mandibular anterior teeth and size of the pulp cavity. The absence of attrition in the mandibular anterior teeth and the "A" type dimension of the pulp cavity of all teeth indicated that the deceased was a teenager.<sup>13,14</sup> Furthermore, the finding that although the tooth crown was complete, the root of the unerupted mandibular third molar was incomplete and thus indicated that the deceased was between 16 and 18 years old<sup>15-17</sup>(Fig.3). Three weeks later an identification was established after the newspapers published a



portrait of the victim together with her estimated age. Her actual age was in fact 18 years old and this was the first person identification case in which the direct digital X-ray system was used in Japan.

### Case 2

On 2 March 1998 a human skull was found in the trawling net of a fishing boat in the coastal waters of Japan 27.3 nautical miles from Inubosaki Lighthouse (Fig. 4).



**Fig.4:** Skull found in Case 2. A: front view, B: right view, C: left view, D: occlusal view of maxilla

Based on circumstantial evidence the Japanese Coast-guard Choshi Division regarded this case as murder and sent the skull to us for dental examination, charting and comparing PM data with AM data of a specific person who had been reported missing for a month. We used the Compuray once again and obtained a number of radiographic images from various angles within a short time (Fig. 5).

Comparing the PM records with the dental ante-mortem X-ray films and records supplied by the missing person's dentist, we found many concordant

**Fig.5:** Post-mortem dental X-ray images of upper jaw obtained using the Compuray

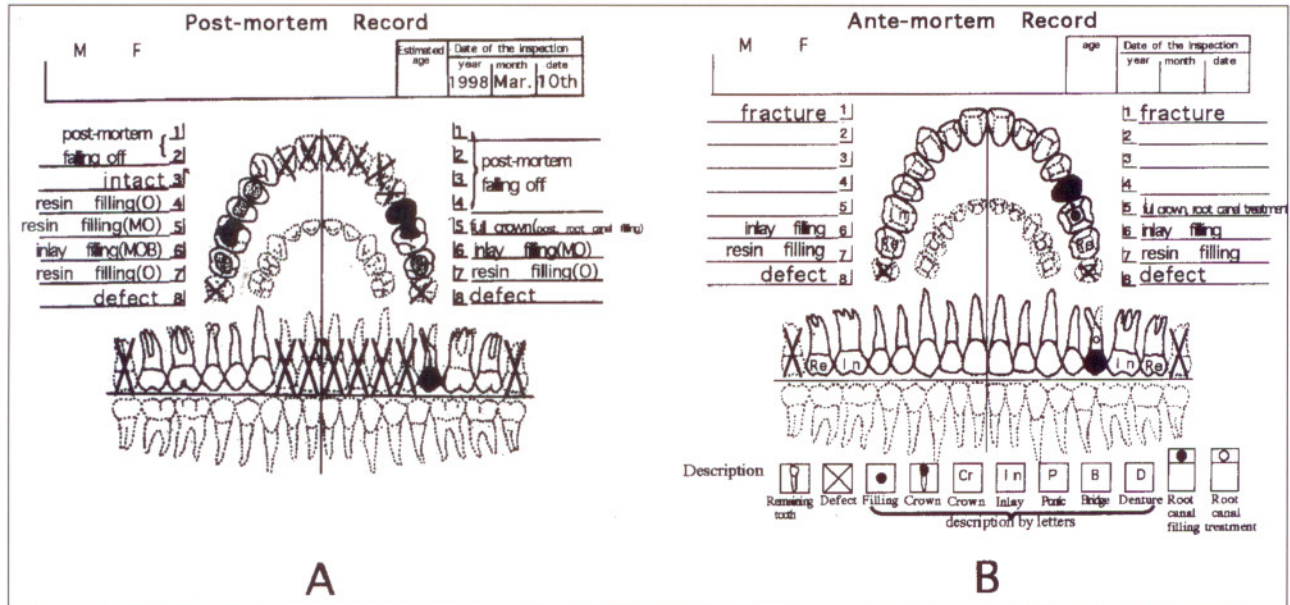


Fig.6: Comparison of dental charts between the ante- and post-mortem records. A: post-mortem record. B: ante-mortem record. Agreements in the methods of dental treatment were observed

points between the two and the skull proved indeed to be that of the missing person (Figs. 6 and 7A and B). We were also able to superimpose the ante- and post-mortem dental images thus confirming that they were from the same person. The superimposition and resulting composite image proved to be a useful diagnostic tool and was obtained rapidly and simply with an image processor (Fig.7C).

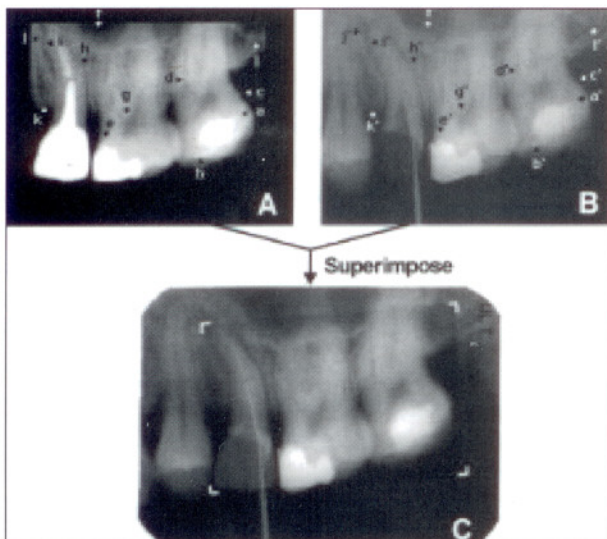


Fig.7: Comparison of X-ray images. A: post-mortem digital X-ray image. B: ante-mortem X-ray photograph. Many identical points (a:a' - k:k') were found. C: superimposition of images A and B.

DISCUSSION

The advantages of the direct digital X-ray system are as follows:

1. The irradiation dose is relatively low.<sup>18</sup>
2. It takes only 2-3 seconds to obtain X-ray images after the exposure, and imaging does not require the additional equipment of darkroom, developer, fixer and the other items for developing conventional X-ray films.<sup>8-11, 19, 20</sup>
3. The images can be easily analyzed, expanded, measured and coloured.<sup>8-11, 19, 20</sup>
4. The images can be stored electronically.<sup>8-11, 19, 20</sup>
5. Receiving, sending and storing clear digital X-ray images through computer networks is effortless.<sup>19, 20</sup>

We consider these advantages to be very relevant to dental identification, and were eager to experience the practical application of the direct digital X-ray system. As a result, in both of the two cases reported, we were able to obtain a large number of radiographic pictures within a remarkably short time, and to enlarge them as required. Further, in Case 2, the comparison of ante- and post-mortem images was possible through enlargement and superimposition. Because superimposition requires ante- and post-mortem images from the same angle it has been somewhat difficult to conduct until now. On this occasion however it was possible to obtain X-ray images

of the body from the same angle as the ante-mortem radiographs which could be displayed on the monitor. The superimposition was then performed rapidly using an image processor, as previously mentioned. In addition, as a result of the development of the transportable digital X-ray system, it is possible to conduct a detailed dental examination in the mortuary.

These results indicate that the direct digital X-ray system is useful and convenient for dental identification and it is felt that these advantages justify its cost (about AU\$40000). In the near future it is expected that this system will be transportable to a location remote from where the ante-mortem dental records are kept, because both ante- and post-mortem records will be transmissible through computer networks as clear digital data. This possibility therefore opens up limitless opportunities for dental identification on a global scale.

#### REFERENCES

1. Amoëdo O. The role of dentists in the identification of the "Bazar de la Charite" Paris, 4th of May. *Dent Cosmos* 1897; 39: 905-12.
2. Suzuki K, Hanaoka Y, Tsai TH. Personal identification case by means of panoramic X-ray films. *Jpn J Legal Med* 1988; 42: 539-45.
3. Suzuki K, Hanaoka Y, Minaguchi K, Inoue M, Suzuki H. Positive identification of dental porcelain in case of murder. *Jpn J Legal Med* 1991; 45: 330-40.
4. Minaguchi K, Hanaoka Y. An identification case of skull and full denture by the method of superimposition and X-ray computed tomography analysis. In: Jacob B, Bonte W, eds. *Advances in forensic science Vol. 7. Forensic odontology & anthropology*. Berlin: Dr. Hans-Joachim Köster, 1995: 184-7.
5. Hanaoka Y, Minaguchi K. D4S43 locus DNA typing in the Japanese population and application to teeth with degraded DNA. *J Forensic Sci* 1998; 43: 406-9.
6. Minaguchi K, Haga T, Hanaoka Y, Hashimoto M, Saitoh H, Kiuchi M. A case of personal identification from a skull harboring unique characteristics. *Proceedings of the 6th Indo Pacific Congress on Legal Medicine and Forensic Science*, 1998: 397-400.
7. Sakoda S, Zhu BL, Ishida K, Oritani S, Fujita M, Maeda H. Dental identification in routine forensic casework: clinical and postmortem investigations. *Legal Med* 2000; 2: 7-14.
8. Mouyen F, Benz C, Sonnabend E, Lodter JP. Presentation and physical evaluation of RadioVisioGraphy. *Oral Surg Oral Med Oral Pathol* 1989; 68: 238-42.
9. Molteni R. Direct digital dental X-ray imaging with Visualix/VIXA. *Oral Surg Oral Med Oral Pathol* 1993; 76: 235-43.
10. Sanderink GC. Imaging: New versus traditional technological aids. *Int Dent J* 1993; 43: 335-42.
11. Hubar JS, Carr RF. Computed dental radiography used to reproduce antemortem film position. *J Forensic Sci* 1999; 44: 401-4.
12. Wood RE, Kirk NJ, Sweet DJ. Digital dental radiographic identification in the pediatric, mixed and permanent dentitions. *J Forensic Sci* 1999; 44: 910-6.
13. Amano J. Medico-legal studies on human teeth. *Jpn J Legal Med* 1951; 5 (Supplement): 170-86.
14. Fujimoto T. Radiographical studies on the pulp-cavity. *The Shikwa Gakuho* 1958; 58: 1-24.
15. Schour I, Massler M. Studies in tooth development. The growth pattern of human teeth. *J Am Dent Assoc* 1940; 27: 1778-1793, 1918-1931.
16. Nortje CJ. The permanent mandibular third molar. Its value in age determination. *J Forensic Odontostomatol* 1983; 1: 27-31.
17. Harris MJP, Nortje CJ. The mesial root of the third mandibular molar - A possible indicator of age. *J Forensic Odontostomatol* 1984; 2: 39-43.
18. Okano T, Seki K, Harata Y, Maki K. Effect of exposure reduction in cephalography with computed radiography: An analysis using a dual-image recording system. *Dentistry in Japan* 1992; 29: 103-7.
19. Ueno A, Hanaoka Y, Kajiwara M, Sato Y, Minaguchi K, Oshida M, Tsuneda N. The application of direct digital X-ray system to dental personal identification. *Proceedings of the 6th International Academy of Dental Computing* 1997; 61.
20. Ueno A, Hanaoka Y, Minaguchi K, Kajiwara M, Sato Y, Oshida M. Application of a direct digital X-ray system to dental personal identification in two murder cases. *Proceedings of the International Association of Forensic Sciences 15th Triennial Meeting* 1999; 158.

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