CQ20 What are useful findings in postmortem images to compare with antemortem information to identify a specific person?

Grade of recommendation: B

Useful findings in postmortem imaging to be compared with antemortem information are of two main types: (1) abnormalities such as from injuries, diseases, scars after healing, scars due to treatment, and implanted medical devices identified in the body; (2) unique anatomical characteristics of the paranasal sinuses, teeth, thorax, and spine.

Explanation--
Findings in postmortem images that are useful to compare with antemortem information

Useful findings in postmortem images for comparing with antemortem information are of two main types: abnormalities and unique anatomical characteristics [1, 2].

1) Abnormalities

Abnormalities, arising from injuries, diseases, scars after healing, scars due to treatment, and implanted medical devices found in the body, may be useful in comparisons for identification. Soft tissue abnormalities may be useful for the identification of specific persons, but abnormalities in hard tissue and from foreign substances are more easily identified by postmortem CT or X-ray.

Medical devices implanted in the body show a past history of injury and disease, and supporting antemortem information may be available [2]. Analysis of metallic medical devices after cremation have shown that intramedullary nails and plaques used in fracture fixation; prosthetic joints of the shoulders, hip, and knees; cardiac valvular prostheses; endoluminal stents; pacemakers; and dental prostheses have been recovered [3]. Medical devices with a serial number, such as prosthetic joints, may lead to a positive identification by removing them at an autopsy and comparing the serial number to the medical record of a missing person [4]. The digital records in an implanted pacemaker or defibrillator may lead to a positive identification. Medical devices without serial numbers, such as wires for metal sutures, screws, pins, and some kinds of stents, may also suggest a positive identification by comparing them to the sizes and batch numbers in the medical record, and the morphology of the antemortem record [5, 6]. A case identified by a foreign object other than a medical device, for example a subdermal 3D art silicone implant, has also been reported [7].

Abnormal development of bones and degenerative changes due to diseases, such as arthropathy, osteophytosis, and ankylosing spondylitis, may be useful in the identification of specific persons by a comparison with antemortem CT and X-ray [2, 8].

2) Unique anatomical characteristics

Unique anatomical characteristics of sites where differences are of an individual nature can lead to a positive identification, even without other abnormalities identified [1, 9]. If antemortem CT or X-ray images are available, the postmortem images of the same site should be compared with details of the anatomical characteristics, including findings of normality and abnormality, to establish a positive identification. In reports of the head region, paranasal sinuses, especially the frontal sinus, are most commonly used [10-12]. For the thorax, identification of specific persons by the clavicle, ribs, and cervical vertebrae [13, 14] using chest radiographs, and by the sternum [15] in addition to the bones mentioned above using postmortem CT, have been reported. For the abdomen, cases identified using the lumbar vertebrae are commonly reported. In such reports, the normal morphology and also degenerative changes caused by aging or disease and bone trabeculae patterns were used [8, 16-18]. The use of trabecular patterns of the upper and lower extremities [19-21] and bone islands [22] have also been reported in identifications of specific persons.

Figure 1 Severely burned corpse

(A) Most of the extremities have disappeared, and the cranial cavity, thoracic cavity, and abdominal cavity are open, making it difficult to distinguish the various organs (top left arrow head side). (B, C) Postmortem CT image shows wires on the sternum. (D) The candidate had a history of valve replacement and the wire-only VR image was compared with (E) the clinical chest XP. There was a match in the position of the valve and of the wire shapes, and this was used in the identification of the individual. If there are medical devices in postmortem images, comparing these with clinical images may help identify an individual.

Identification of specific persons by dental methods

It is known that findings of the teeth and jaws, so-called dental findings, are useful when compared with antemortem information in identification of specific persons. Comparing the dental findings on antemortem and postmortem dental charts is a well-known method. However, radiological records and comparisons serve as a more objective indicator for identification of specific persons, more so than dental charts, which are written subjective records. Dental diseases, treatment, and unique anatomical

characteristics are useful, as well as using the bone morphology. Dental treatment, such as root canal fillings and crown prostheses, and unique characteristics, such as the crown shape, root shape, root length, root curve, pulp shape, and the relationship between adjacent teeth can be used to establish a positive identification [23]. The accuracy of identification by dentists by comparing intraoral radiographs, classical dental radiographs, comparison between intraoral radiographs and orthopantomograms, a type of tomography, and comparisons between any type of dental radiographs have all been reported as 85% to <90% [24-26]. It is sometimes difficult to compare details of the sites in the crown and the shape of metal dental prostheses based on metal artifacts in postmortem CT images [27-28], CT images may allow a comparison of the presence/absence of teeth and findings in the jaw [28]. A study comparing CT images and periapical radiographs from other cadavers has suggested significant discrepancies in the anatomical positioning of the teeth, suggesting the possibility of identification of specific persons using postmortem CT compared with dental radiographs [29].

Automatic comparison

As information technology advances, methods of identification of specific persons by automatically (relying on a mechanical device) matching data of two or more images or image datasets have been developed. The purpose and method of automatic comparisons vary: automation of candidate selection [30] or the process of the comparison [31] to aid victim identification after large-scale disasters, automation of the comparison process to improve the repeatability and reproducibility of identification of specific persons [32], and establish automatic systems to place medical images in the correct patient folders in hospitals [33].

Column---

In image diagnosis in a dental clinic, it is common to perform intraoral radiographic (dental radiography) and panoramic radiographic examinations. Installations for these are available at more than 95% of dental treatment facilities in Japan (about 70,000 facilities), and the number of images taken annually is said to be about 100 million for oral photography and about 12 million for panoramic photography.

Currently, thousands of panoramic imagers are produced annually in Japan, and most use the semiconductor digital method. In this method, the principle of tomosynthesis is being introduced, and images of multiple tomographic regions can be obtained. As a result, the "blurred image caused by the anterior tooth parts deviating from the tomographic region", which is a problem in conventional panoramic radiography, is improved. Furthermore, in tomosynthesis, the image quality is improved by autofocusing, which reconstructs the image for the optimal tomographic region. And, with the latest equipment, it is possible to output images of the optimum trajectory and angle of a target tooth from

panoramic 3D data where differences in magnification ratio depending on the site are corrected, and even with panoramic images, a clear image similar to intraoral radiography can be obtained.

For postmortem images, there are few facilities where intraoral radiography or panoramic radiography (a device that can photograph in the supine position is required) is performed and matching with the dental image data of a dead person becomes difficult.

There are few facilities that can capture postmortem panoramic images, and it is likely that there are many cases where panoramic reconstructions are performed from CT images. In this case, positioning of the head (face) during image recording and pointing during the image reconstruction are important for obtaining detailed images by CT. During postmortem CT image recording, it is desirable to place the subject in the supine position and set the head position so that the occlusal plane (the surface where the upper and lower jaw teeth are in contact) is parallel to the CT gantry. When the image is reconstructed, pointing is performed with a horizontal image, so if the head is tilted significantly, a large adjustment of the central axis is required when reconstructing the panorama. In addition, when there are metal parts due to dental treatment in the oral cavity, the closer the occlusal plane is to the gantry, the less the metal artifacts stand out in the image. At the time of panoramic reconstruction from CT, the pointing is performed along the morphology of the mandible at the height of the horizontal occlusal plane. In this situation, caution is required because the mandible is horseshoe shaped and the anterior teeth are easily displaced from the observation area. In the horizontal image, a reference point can be set on the dorsal side of the mandibular condyle, and from there, pointing forward, pointing with the positions of the ramus of mandible, the lower first molar, the canine, and the central incisor as guides, an inverted U draws a letter-shaped orbit. Here, at least 7 to 9 or more points are considered necessary to obtain a detailed image. For more detailed observations of tooth conditions (morphology and treatment marks), image reconstruction should be performed separately for the upper and lower jaw dentitions. To bring the reconstructed image closer to the antemortem panoramic image, as shown in Fig. 2, the occlusal plane draws a gentle downward convex curve from the midline to the molars. This means that the posterior edge of the mandibular branch should be in a state almost vertical to the occlusal plane.

Figure 2 Panorama reconstructed image obtained from postmortem CT data
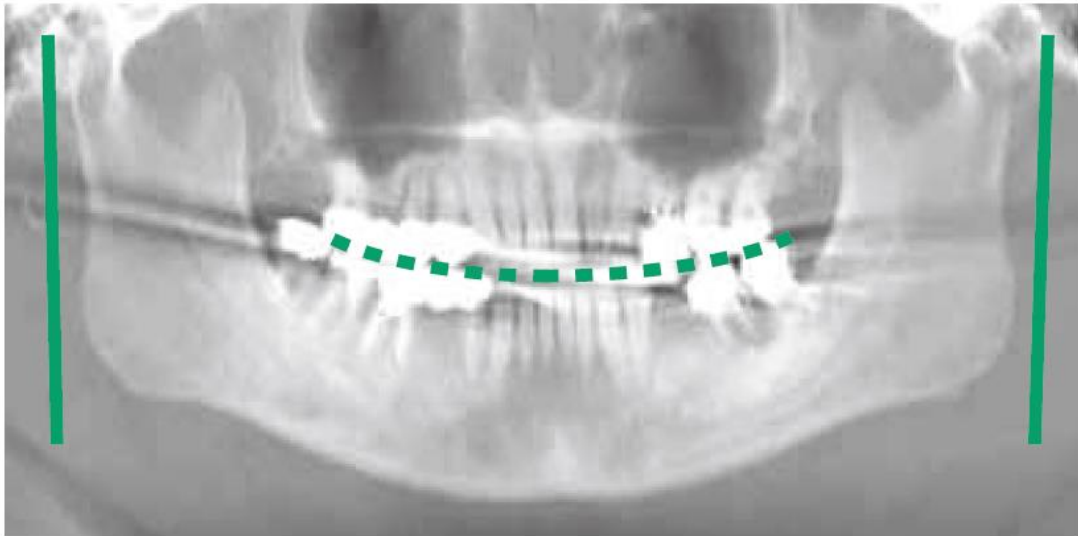
The occlusal plane forms a gently curved line (dotted line) that is convex downward (concave). Bilateral posterior margins of the mandibular branch (solid line) are perpendicular to the occlusal plane.

Literature search formula and literature selection
PubMed(2019/2/10)

#	Search formula	Number of documents
1	((postmortem) OR post-mortem) OR "post mortem	135,990
2	(#1 AND imaging) OR (#1 AND CT) OR (#1 AND "computed tomography") OR (#1 AND MR) OR (#1 AND "magnetic resonance") OR (#1 AND MDCT) OR (#1 AND MSCT) OR (#1 AND X-ray) OR (#1 AND "X ray") OR (#1 AND Xray) OR (#1 AND roentgeno) OR (#1 AND radiograph) OR (#1 AND radiography)	26,644
3	((((((("personal identification") OR "personal identity") OR "human identification") OR "dental identification") OR "disaster victim identification") OR "forensic anthropology") OR "forensic odontology"	7,189
4	#2 AND #3	378

Ichushi（Medical Journal）(2019/2/13)

#	Search formula	Number of documents
1	((死後/AL) and ((FT=Y) and AB=Y and PT= 会議録除く)) or ((死亡時/AL) and ((FT=Y) and AB=Y and PT= 会議録除く))	4,195

2	(((画像診断/TH or 画像診断/AL)) and ((FT=Y) and AB=Y and PT= 会議録除く)) or (((X 線CT/TH or CT/AL)) and ((FT=Y) and AB=Y andPT= 会議録除く)) or (((MRI/TH or MRI/AL)) and ((FT=Y) and AB=Yand PT= 会議録除く)) or (((X 線/TH or x 線/AL)) and ((FT=Y) andAB=Y and PT= 会議録除く))	223,650
3	(個人識別/TH or 個人識別/AL) or (個人識別/TH or 身元確認/AL)	2,142
4	#1 and #2 and #3	22

From other than search formula

[1, 3, 10, 21, 30, 33]

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