REVIEW ARTICLE

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Panoramic and periapical radiographs utilization in Disaster Victim Identification (DVI): narrative review

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ABSTRACT

Objectives: The purpose of this narrative review is to discover radiographic images in panoramic and periapical radiographs that are used as identifiers and to compare the use of panoramic and periapical radiographs in identification based on DVI.

Review: The databases used in this narrative review are Google Scholar, PubMed, and Science Direct. A total of 1258 search results appeared based on keywords. The search results were selected by title and abstract according to their relevance to the review topic, then results are selected again based on the inclusion and exclusion criteria. Total of 38 literatures were reviewed. This review shows radiographic identifiers used in panoramic radiographs are tooth restorations, crown, Root Canal Treatment (RCT), dental bridge, dental implants, maxillary sinus, rectilinear metal plate, orthodontic brackets, tooth anomaly, and root morphology. The radiographic identifiers used in periapical radiograph are tooth restorations, PSA, tooth anomaly, and root morphology. In this review, 53.8% of the literatures used panoramic radiograph for identification, whereas 46.2% used periapical radiograph.

Conclusion: This review concluded that the most used radiographic identifier in panoramic radiograph is tooth restoration (57,1%) whereas in periapical radiograph is RCT (83,3%). Panoramic radiography were used in 53,8% of the literatures in this review, it was used more than periapical radiography.

Keywords: *Panoramic radiograph, periapical radiograph, forensic odontology, DVI*
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INTRODUCTION

Identification process is an important part of forensic investigation in order to discover the identity of an unknown victim.[1] Identification of an unknown body will allow the family of the deceased to hold funeral appropriately and manage the deceased's legal affairs such as death certificate, business agreement, and insurance.[2] In 1984 the International Criminal Police Organization (Interpol) developed a method to identify victims who could not be identified. This identification method is hereinafter referred to as Disaster Victim Identification (DVI).[3] According to the Interpol DVI guidelines, the primary identification methods in DVI are friction analysis, dental analysis, and DNA analysis.[4]

Dental analysis can be done with the aid of dental radiographs since it's an essential diagnostic tool in dental practice.[5] Dentists rely on radiographs to understand more about patient's oral condition such as the presence of lesions, root abnormality, dentition, and also as an aid for root canal treatments.[6] Apart from being a diagnostic tool in dental practice, radiographs are also considered a dental record which contain a lot of valuable information about the patient's condition at the time it was produced.[7]

Panoramic and periapical radiography are commonly used in dental practice. Panoramic radiograph can show maxillary and mandibular teeth as well as the supporting bone structures in one image. Periapical radiograph usually presents two to four teeth from the crown to the apex.[8] This study will review the use of both radiograph in DVI based identification and what kinds of radiographic image on panoramic and periapical radiographs used as a source of identification. The aim of this review is to compare the use of panoramic and periapical radiographs in DVI process and obtain information regarding which radiography between the two is frequently used in DVI.

REVIEW

Literature search was performed on 3 databases, Google Scholar, PubMed, and ScienceDirect. The search results were selected and eliminated based on selection criteria. Inclusion

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criteria in this study was original article, case reports, and books about forensic dentistry, forensic radiology, and DVI, literatures published between 2005-2020, and literatures written in Indonesian or English. Exclusion criteria in this study was duplicated literatures, review articles, original article that does not include research method, and literatures using other radiography techniques other than panoramic and periapical. Based on the selection criteria 36 literatures were collected and reviewed.

DISCUSSION

IMPORTANCE OF RADIOGRAPH IN DVI PHASES

Postmortem (PM) dental radiographs production is a mandatory step in the Postmortem phase.[4] In the Postmortem phase, PM dental radiographs are taken using various radiographic techniques.[9] PM radiographs have a big role in this phase because they can show dental and oral conditions of the victim that cannot be detected only by visual examination, such as root canal treatment and periapical lesions[10]. In addition, PM radiographs are very helpful in identifying victims who do not have AM radiographs as well as victims with minimal dental care, such as children.[11,12]

In the Antemortem phase, radiographs must be submitted to the DVI team if available. The doctor in charge of the alleged victim's medical record is required to submit the dental record including the existing radiograph.[13] Few studies showed significantly higher success rate of identification of tsunami victims in Thailand who had AM dental radiographs than those victims who did not have AM dental radiographs. The success rate of identifying tsunami victims with dental radiographs is 80-96%.[15,14] In a case of bushfires, 60% of the victims were identified based on dental information, 40% of which came from dental radiographs.[16]

Dental radiographs also play a role in the Reconciliation phase, particularly in comparative identification methods. As many as 72% of positive identifications in modern forensic science result from comparative identification method that compares AM and PM radiographs.[17] Identification by the comparative method is highly dependent on the availability of AM radiographs.[18] Comparative method is considered more efficient for identification, therefore dental radiographs are important in the Reconciliation phase.[14]

Radiographs have a major role in the identification process, especially in phase II (Postmortem), III (Antemortem), and IV (Reconciliation). This shows the importance of dental records and radiographs in DVI. Identification based on radiographs can shorten the time and also increase the reliability of identification.[19,20] Antemortem dental data such as radiographs can provide more reliable information than written records.[15]

RADIOGRAPHIC IMAGES IN PANORAMIC AS A SOURCE OF IDENTIFICATION

Radiographs have been used in the identification of disaster victims, both mass and non -mass disasters, since 1921.[17] The most frequently used dental radiographs for identification purposes are panoramic, bitewing, and periapical.[7] Main function of forensic odontology is to identify the victim's body based on the individual characteristics of the teeth. The individual characteristics in question can be in the form of anatomical structures, pathological conditions, dental anomalies, or the results of dental treatments carried out during life.[13, 21] Panoramic radiograph is evidence of the presence of these individual characteristics. There are 13 out of 36 literatures that mention the types of radiographs and dental features that are used as sources of identification. The radiographic features on panoramic radiographs that can be used as DVI standard identification are presented in Table 1.

Based on Table 1, identification can be known based on the restorative dental care received by the patient during his life such as jacket crowns, dental restorations, root canal treatment, fixed dentures, and dental implants.[26,27,28,13,10]

Table 1. Radiographic images in panoramic radiograph which are used as identification sources

SOURCE OF IDENTIFICATION	REFERENCES
DENTAL TREATMENTS	
Crown jackets	Bux et al. (2006), Conceição et al. (2018), Silva et al. (2017)
Tooth restorations	Bux et al. (2006), Silva et al. (2012), Silva et al. (2017), Conceição et al. (2018)
Root Canal Treatments	Bux et al. (2006), Silva et al. (2017), Conceição et al. (2018)
Dental bridge	Bux et al. (2006), Conceição et al. (2018)
Dental Implant	Conceição et al. (2018), Silva et al. (2017)
Rectilinear metal plate	Silva et al. (2011)
Orthodontic brackets	Silva et al. (2011), Picoli et al. (2019)
ANATOMY	
Maxillary sinus	Lundberg et al. (2019)
Tooth anomaly	Silva et al. (2011)
Root morphology	Silva et al. (2011)

Restorative treatment is a potent source of identification because dentists carve each restoration according to the shape of each patient's teeth so that no restoration is the same for each individual. Therefore, restorative treatment adds unique value to each person.[29]

Some studies successfully obtained positive identification using the radiographic image of the dental crowns.[26,30] Dental crowns generally remain firmly attached to the teeth in disaster situations.[30] Apart from crowns, radiographs of dental restorations (dental fillings), root canal treatment, and fixed dentures are also useful in revealing the identity of the victim.[26,13] The radiographic appearance of dental implants can help lead to a positive identification.[28, 26, 30] Radiographs that are used to plan the installation of dental implants as shown in Figure 1 greatly assists the identification process as an AM data. The AM radiograph (Figure 1) confirmed the dental implants seen on the PM radiograph (Figure 2), so it was concluded that the PM and AM radiographs belonged to the same person.[10]

RADIOGRAPHIC IMAGES IN PERIAPICAL AS A SOURCE OF IDENTIFICATION

The radiographic technique that is often used in the identification process, especially when making PM data, is periapical.[9] Radiographic features that can be used as a source of identification in periapical radiographs are shown in Table 2.

Based on Table 2, identification can be obtained through the radiographic appearance of root canal treatment seen on the periapical radiograph of the PM. A study reported the process of identifying accident victims who were identified from the

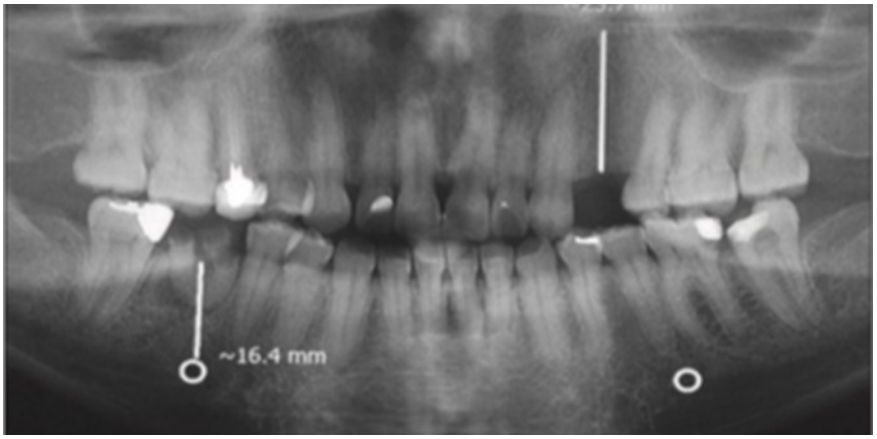

Figure 1. Antemortem panoramic radiograph for dental implant planning

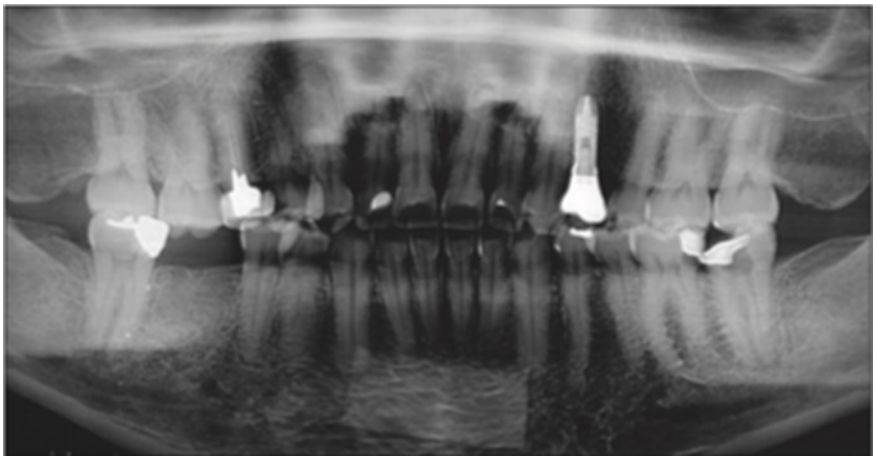

Figure 2. Postmortem panoramic radiograph showing a dental implant in the same location as in Figure 1

Table 2. Radiographic images in periapical radiograph which are used as identification sources

SOURCE OF IDENTIFICATION	REFERENCE
Tooth restoration	Forrest and Wu (2010), Hinchliffe (2011), Forrest and Wu (2010)
Root Canal Treatments	Forrest and Wu (2010), Silva et al. (2014), Silva et al. (2016), Berketa et al. (2019), Forrest and Wu (2010)
Root Morphology	Silva et al. (2016)
Tooth anomaly	Silva et al. (2016)

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Figure 3. Comparison between panoramic and periapical radiograph based on dental feature used as identification source

radiographic images of endodontic treatment on teeth 15 and 22.[33] Another study also reported the identification of root canal treatment performed on tooth 34 which showed compatibility with victim AM dental records. In addition to root canal treatment, AM and PM radiographs of victims showed similar premolar morphology, absence of molars, and the presence of alveolar bone loss in the mandibular left molar area.[6]

Other than RCTs a person can also be identified by depicting the residual endodontic material seen on periapical radiographs. Radiopaque images of residual endodontic material provide clues about the identity of victims whose jaws are edentulous.[34] Residual material of RCT also helped in identifying fragments of the jaw charred from a plane crash, the residual root canal treatment material was caught on periapical radiographs as radiopaque image (Figure 3).[31]

One journal mentioned identification of victims through radiographic images of dental anomalies in the form of dilaceration of tooth 45 and the root of tooth 47 which had not been completely closed. Dental anomalies are individual characteristics that are valuable for identification.[13, 21]

Based on the explanation above, a comparison of the use of radiographic images of dental features in panoramic and periapical radiographs is presented in Figure 4.

The radiographic appearance of dental fillings in panoramic radiographs is the most widely used dental feature as a source of identification in cases of DVI standard identification, which is 57.1%. Tooth fillings are the most widely used dental features as a source of identification because each dental restoration is shaped by the dentist according to the shape and color of the patient's natural teeth. Therefore, the form of restoration for each individual is different.[29] In the periapical radiograph, the radiographic image of root canal treatment was the most widely used as a source of identification, which was 83.3%. Root canal treatment always use periapical radiographs before, during, and after treatment to control the results of treatment, so these radiographs are very often obtained as victim AM data in DVI.[31]

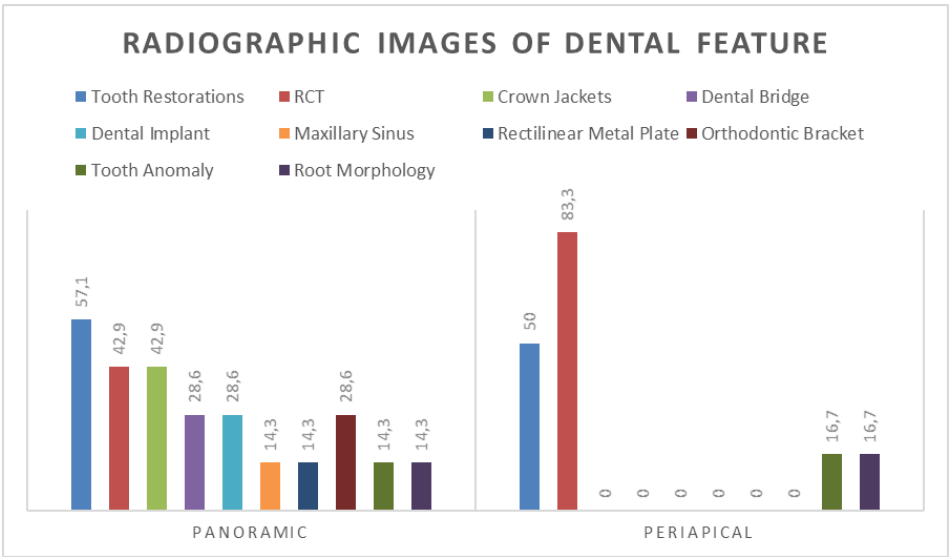

Figure 4. Comparison between panoramic and periapical radiograph based on dental feature used as identification source

Table 3. Comparison between panoramic and periapical radiographs based on the usage in identification

Radiograph	Reference	Percentage
Panoramic	Bux et al. (2006) Silva et al. (2011) Silva et al. (2012) Silva et al. (2017) Conceição et al. (2018) Picoli et al. (2019) Lundberg et al. (2019)	53,8%
Periapical	Forrest and Wu (2010) Forrest and Wu (2010) Hinchliffe (2011) Silva et al. (2014) Silva et al. (2016) Berketa et al. (2019)	46,2%

IMPORTANCE OF PANORAMIC AND PERIAPICAL IN IDENTIFICATION PROCESS

Based on Table 3, it is known that 53.8% of panoramic radiographs were used and 46.2% of periapical radiographs were used to identify victims in the literature reviewed. The gap difference in the use of these two radiographs is not too big because both radiographic techniques are commonly encountered in dental practice.[8]

CONCLUSION

Radiographic identifiers on panoramic radiographs in DVI based identification were images of tooth restorations, dental crown, RCT, dental bridge, dental implants, maxillary sinus, rectilinear metal plate, orthodontic brackets, tooth anomaly, and root morphology. The most used radiographic identifier was tooth restorations (57,1%). Radiographic identifiers on periapical radiographs in DVI based identification were images of tooth restoration, RCT, root morphology, and tooth anomaly. Root Canal Treatment was the most used identifier (83,3%). Periapical radiographs were used in 53,8% case whereas panoramic were used in 46,2%.

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FOOTNOTES

All authors have no potential conflict of interest to declare for this article.

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