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Technical Note

Technical note: Intra-alveolar morphology assessed in empty dental sockets of teeth missing post-mortem

Lucas Raineri Capeletti[a], Ademir Franco[b], Rogério Vieira Reges[c], Rhonan Ferreira Silva[d,*]

[a] Department of Dentistry, Federal University of Goiás, Brazil
[b] Department of Stomatology, Federal University of Paraná, Brazil
[c] Department of Dental Materials, Paulista University, Brazil
[d] Department of Forensic Odontology, Federal University of Goiás, Brazil

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ABSTRACT

Dental human identification relies on distinctive traits detected and compared between ante-mortem (AM) and post-mortem (PM) data. Several distinctive traits may be found in dental roots, such as dilacerations and bifurcations. However, teeth are often dislodged during the manipulation of skeletal remains, charred bodies and bodies retrieved from water. In these situations the identification process is hampered. The present study aims to retrieve information of teeth missing PM through the investigation of intra-alveolar morphology in empty dental sockets using different dental impression materials. This study was conducted using a dry human skull and 6 techniques for intra-alveolar impression, namely: (1) alginate using a dental tray; (2) heavy-body condensation silicone (HBCS) using manual compression; (3) HBSC using a blunt tip probe; (4) HBCS using a dental tray; (5) light- and HBCS using a syringe and a dental tray; and (6) polyether using a syringe and a dental tray. These techniques were evaluated based on 5 criteria: (I) intra-alveolar flow; (II) registration of apical morphology; (III) tensile strength; (IV) complexity; and (V) cost. The best outcomes considering the cost and benefit relation of each technique were observed in the following order: techniques #3 > #2 > #5 > #6. Techniques #1 and #4 did not reach satisfactory outcomes for application in the forensic routine. Forensic dentists must be aware of the possibility of retrieving PM dental information even in the absence of teeth. The impression of intra-alveolar morphology may contribute significantly as source of PM dental information for human identifications.

1. Introduction

According to Interpol, fingerprints, teeth and DNA analyses consist of primary methods scientifically reliable for human identification [1]. These analyses have in common a comparative pathway towards human identification [2]. In forensic odontology, comparisons are performed between ante-mortem (AM) and post-mortem (PM) data, which consist of clinical records retrieved from dental offices and dental information obtained from the deceased, respectively [3]. Teeth are considered especial tools for human identification because they resist to strong environmental factors [4], such as heating and degradation [5]. For that reason, the human teeth are useful for complex human identification cases involving charred bodies and skeletal remains [3].

However, even complex cases can get worse—especially if teeth are missing post-mortem (PM) [6]. This situation is justified based on the decomposition of periodontal soft tissues, such as the cementum, periodontal ligament fibers and gingiva, leading to dental dislodgement [7]. Macroscopically, teeth may be considered missing PM when they present empty and unhealed dental sockets with sharp bone crests [8]. Radiographically, empty sockets of teeth missing PM present a radiopaque lamina dura outlining the root-shaped intra-alveolar morphology [9].

Although teeth missing PM are included in the list on Interpol dental codes for human identification [10], the remaining empty sockets did not receive major attention. The importance of investigating the intra-alveolar morphology of empty sockets relies on the possibility of reconstructing the shape of missing roots [11–13]. More specifically, dental roots may contribute significantly to comparative human identifications based on their morphological traits potentially distinctive [14]. Currently, intra-alveolar morphology of empty sockets may be assessed in the forensic routine within periapical and panoramic radiographs,

* Corresponding author at: Federal University of Goias, Av. Universitaria, Esquina com 1ª Avenida s/n, Setor Universitário, 74605-220, Goiania, Goias, Brazil.
E-mail address: rhonansilva@gmail.com (R.F. Silva).

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which are bidimensional (2D) image modalities. For more reliable analyses, computed tomography may be used to enable a tridimensional (3D) assessment of root morphology. On the other hand, tomographic imaging is still not available in many medico-legal institutes worldwide.

The present study aims to assess the intra-alveolar morphology in empty dental sockets using impression materials to reconstruct the 3D shape from the roots of teeth missing PM.

2. Material and methods

A cross-sectional and experimental study was designed and conducted after the approval of the Committee of Ethics in Research of the Federal University of Goias, under the protocol number 068843/2013.

A human mandible retrieved from unknown skeletal remains was selected from the archives of the local medico-legal institute. The mandible presented the following teeth: right second molar (#47), right first molar (#46), right second premolar (#45), right first premolar (#44), right canine (#43), right lateral incisor (#42), right central incisor (#41), left central incisor (#31), left lateral incisor (#32), left canine (#33), left first premolar (#34), left second premolar (#35), and left second molar (#37). No periodontal soft tissue was present allowing the removal of the anterior teeth from their alveolar sockets (Fig. 1). The teeth were removed manually from the sockets simulating teeth missing PM. Intra-alveolar inspection was performed and indicated full morphological integrity and the lack of foreign bodies. The mandible with 6 empty sockets in the anterior region underwent 6 techniques for taking impressions of the intra-alveolar morphology.

A thin layer of vaseline was applied inside the socket. Jeltrate Dustless® alginate (Dentsply®, Petrópolis, Brazil); Clonage® condensation silicone (DFL®, Rio de Janeiro, Brazil); and Impregum Soft® polyether (3M ESPE®, Sumare, Brazil) were used as impression materials (Fig. 2). Technique #1 consisted of inserting alginate into the empty sockets of the mandible using a perforated partial dental tray; Technique #2 consisted of inserting heavy-body condensation silicone into the empty sockets of the mandible using manual compression; Technique #3 consisted of inserting heavy-body condensation silicone into the empty sockets of the mandible using a blunt tip probe; Technique #4 consisted of inserting the heavy-body condensation silicone into the empty sockets of the mandible using a perforated partial dental tray; Technique #5 consisted of inserting light- and heavy-body condensation silicone into the empty sockets of the mandible using a syringe for elastomer in combination with a perforated partial dental tray; Technique #6 consisted of inserting polyether into the empty sockets of the mandible using a syringe for elastomer in combination with a custom acrylic dental tray.

The negative impressions of the empty sockets were cut individually using a surgical scalpel blade n.15, and compared directly with the teeth removed from their respective sockets (Fig. 3). In this context, the roots of the 6 anterior teeth (from #33 to #43) were used as controls. Both the impressions and the teeth removed were registered with a Nikon D-3000® professional camera (Nikon®, Tokyo, Japan) and an ABFO #2 scale (American Board of Forensic Odontology, USA) for direct photographic comparison. The 6 techniques were analyzed macroscopically and subjectively (as performed more commonly in human identifications) by a single experienced forensic dentist. The impression materials were analyzed (1) based on their intra-alveolar flow; (2) based on their capacity for registering the intra-alveolar apical morphology; (3) based on their tensile strength (capacity to resist tearing); (4) based on their complexity; and (5) based on their cost. For the first 3 criteria, the techniques were classified as satisfactory or unsatisfactory, while for the 2 remaining criteria the techniques were classified as high or low.

Satisfactory performances were considered when the material reached the apical region of the socket (1st criterion); when the material registered the apical morphology including the potential depressions, foraminae and curvatures of the socket (2nd criterion); and when the material presented proper tensile strength to resist damages during the impression (3rd criterion). Oppositely, unsatisfactory performances were considered if the material did not reach the standards mentioned above. The techniques were considered as highly complex (4th criterion) when they required the combination of 2 or more impression materials and instruments (e.g. the material, the individual tray and the syringe for application); and low-cost (5th criterion) when less than 50.00 dollars were spent with the necessary material and instruments. The results were tabulated for discussion.

3. Results

The intra-alveolar impression taken with alginate and a perforated partial dental tray (technique #1) resulted in unsatisfactory outcomes considering the lack of capacity to flow towards the apical region (1st criterion), the lack of capacity to register the apical morphology (2nd criterion) and the lack of capacity to resist tensile forces (3rd criterion). On the other hand, this technique had low complexity (4th criterion) and cost (5th criterion) (Table 1).

The heavy-body condensation silicone applied with manual compression (technique #2) presented satisfactory flow (1st criterion) but did not register the apical region properly (2nd criterion). The material resisted properly to tensile forces (3rd

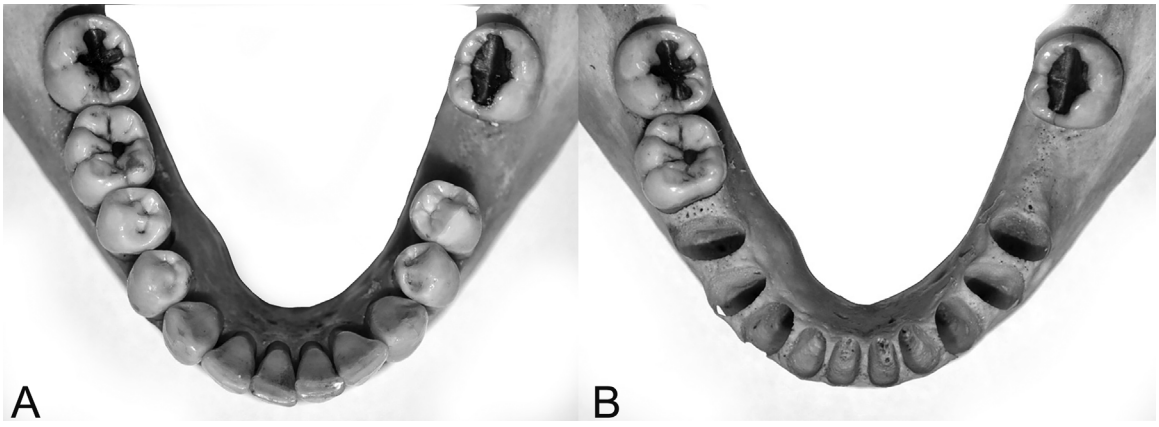

Fig. 1. Human mandible in occlusal view with (A) and without (B) anterior teeth and premolars.