Morphological analysis of dental implants – forensic significance

Adamantia Byraki, Anca Viochița Costea, George Cristian Curcă, Sorin Hostiuc*

Abstract: Dental implants became in the last 15-20 years a very common procedure with minimal risks and a continually decreasing price tag. Dental evidences are one of the most widely used tools in forensic identifications having some obvious advantages: a low cost, human teeth are the best preserved body parts, past dental records are often available, and dental characteristics are unique to each individual. Dental implants, throughout their morphological characteristics give a supplementary layer of evidence during odontological identification, increasing the chances for a positive proof of identity. In this short presentation we will highlight the most useful characteristics of dental for medical legal practice.

Key words: Dental implants, Forensic identification, Forensic odontology, Radiodensity

Dental evidences are one of the most widely used tools in forensic identifications (besides fingerprinting and DNA profiling) having some obvious advantages: a low cost, human teeth are the best preserved body parts due to their hardness and resistance to corrosion, making them ideal in mass disasters, terrorist attacks, wars, etc., past dental records are often available, dental characteristics are unique to each individual (even genetic identical twins have different odontological profiles)[1-3]. In the last years dental implants were increasingly more often used, making them an important addition to dental identification, especially as there are cases where dentition is entirely constructed from implants.


Dental implants are usually classified according to implant design, properties and attachment mechanism. According to the design, implants can be subperiosteal, endosteal, transosteal and epithelial. Subperiosteal implants are custom made, designed to be placed between bone and gums, and used mostly in advanced jaw bone resorption when endosteal implants are of limited use. Endosteal implants are the most frequent type; they are devices placed into the alveolar and/or basal bone and transsects only one cortical plate.

Transosteal implants are combining both subperiosteal and endosteal implants, while epithelial implants are inserted into the oral mucosa. There are two main types of attachment mechanisms: periodontal fibers (mostly theoretical as there is no known material which can stimulate the growth of these fibers) and osteointegration.

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Implant material properties can be classified by their physical, chemical, mechanical and biological properties [5]. From a medico-legal point of view however the most useful are those related to radiological appearance and chemical composition, both useful in identification.

**Radiological assessment**

Radiological assessment in dental implantology is essential both in the preoperative state - to determine the state of the underlying bone, position and condition of the remaining teeth, condition of oral soft tissues and hygiene status, and postoperative - to determine the position of the implant or the appearance of possible complications. Radiological assessment can be realized throughout either simple radiography or (recommended) dental panoramic CT or MRI. In either case, it must reveal all the parameters pointed out in table 1.

<table>
<thead>
<tr>
<th>Position and size of relevant normal anatomical structures (inferior dental canal, mental foramina, incisive foramen and canal, nasal floor. [4, 6]</th>
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</thead>
<tbody>
<tr>
<td>Position and shape of the antral region [4]</td>
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<tr>
<td>Preexistent pathologies (both soft and hard tissue)</td>
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<tr>
<td>Presence of retained roots or buries teeth [4]</td>
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<tr>
<td>Quantitative analysis of alveolar crest/basal bone: shape, width, height [4]</td>
</tr>
<tr>
<td>Bone density: amount of cortical bone, density of trabecular bone and size of trabecular spaces [7, 8]</td>
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<tr>
<td>Periimplant radiolucency- absent if implant is successful[9]</td>
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<tr>
<td>Vertical bone loss – less than 0.2 mm annually (after the first year) if implant is successful [9]</td>
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<tr>
<td>Position of the fixture in the bone</td>
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<tr>
<td>Fixture relation to neighboring anatomical structures</td>
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<td>Healing and integration of the fixture in the bone</td>
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<td>Development of associated diseases</td>
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<tr>
<td>The fit of the abutment to the fixture and crown/prosthesis</td>
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<tr>
<td>Implant position and angles [9]</td>
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<td>Implant characteristics [10]</td>
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<tr>
<td>Fractures of the implant/prosthesis [4]</td>
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**Table 1.** Criteria for radiological implant assessment

As endosteal implants are the most common we will be focusing on them further in this article. In order to properly identify a certain implant, one must take into consideration that their radiological image may depend not only upon the intrinsic implant characteristics but also on the chosen radiological technique, as various horizontal rotations or vertical inclinations can produce very different two-dimensional representation of the analyzes tri-dimensional design.
### Table 2. Main morphological characteristics of dental implants

<table>
<thead>
<tr>
<th>Body Thread Shape</th>
<th>Cervical Shape</th>
<th>Apex Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-shaped, cylinder [Aesthura classic (3.75)]</td>
<td>Wider than body [Osteocare, Advanced (4.5)]</td>
<td>Domed apex [AdVent (5.7)]</td>
</tr>
<tr>
<td>V-shaped, tapered [Accel-Tapered (5.6)]</td>
<td>Straight transition from body [Cortex, 1]</td>
<td>Cone apex [Allfit BCS/BCS A]</td>
</tr>
<tr>
<td>Square body, tapered [Dentoflex, Conical HI]</td>
<td>Narrow transition from body [TFISystems SRL, Conical large]</td>
<td>Flat apex [Osteocare, Advanced (4.5)]</td>
</tr>
<tr>
<td>Reverse buttress body thread, tapered [Apolonia Internal Tapered Type (4.8)]</td>
<td>Angled neck [Co-Axis BAT12d (5.0)]</td>
<td>Flared apex [Sargon Standard]</td>
</tr>
</tbody>
</table>
The radiographs should be taken with the beam perpendicular on the long axis of the implant, in order to minimize distortions; alternate, a second radiograph, at 30 degrees rotation to the long axis/first X-ray beam could add more information about the dental pattern.

A radiopaque object of known size, placed on the occlusal part of the implant/crown is also useful as it aids subsequent implant measurements [6, 7].

**Morphological assessment**

Sahiwal designed a model for implant characterization by dividing the implant in three main parts (apical, midbody and coronal) and describing a set of basic characteristics on each[11-13], as follows:

- **Coronal characteristics:** description of the prosthetic interface (external or internal hex, morse taper or others), the flange (absent, wider than the implant body, straight transition from the implant to the flange, smooth flare from the implant rod to the prosthetic interface, elliptical), and any unique characteristics (e.g. groove below the flange, fine threads on the entire flange, apical part of flare grooved);

- **Midbody:** threaded (shape – V-shaped, square or reverse buttress, presence of grooves or any other unique characteristics) or non-threaded, tapered or non-tapered, presence of other unique characteristics (e.g. stepped, presence of multiple grooves, diamond shaped matrix, multiple types of coatings, expanding screw in the middle of the body, very thin or wide threads, etc.);

- **Apical:** shape (V-shaped, flat, curved), holes (round, oval), presence of an apical chamber, presence and number of grooves, unique characteristics (e.g. two rows of holes, holes and grooves alternate, grooves continuous with body, presence of dimples, expanding screw in middle, etc.). For the most frequent types - see Table 2.

**Restorative materials assessment**

Implant places restoration is classified in screw retained and cement retained.[20] Even though screw retained implants are associated with a lower prevalence of periimplant diseases nowadays cement retained ones are the most frequent due to improved esthetics and lack of screw-retained implant problems (screw loosening, implant anulation, passive fit, lack of screw holes resulting in a diminished number of fractures, easier access in the posterior part of the mouth, increased cost, increased complexity of components and laboratory procedures [21], more prone to fractures [22], etc.)

There are many types of dental cements used in implantology, some being implant-specific. Dental cements are classified according to their physical properties, material, purpose (interim, provisional, definitive), unique characteristics (anticaries activity, ion-exchange, tooth adhesion), and implant specific properties (retrievability, adherence to metal abutments, ease of removal of excess cement) [20].

As with the implants, restoration cements are useful in identification throughout their radiological and chemical characteristics. Cement radiodensity is dependent on many factors, its composition being the most significant [20], although material thickness, exposure setting, angulation of the X-ray beam, methodology for evaluation, experience of the radiologist, the used software, etc are involved as well. The mean tooth density is around 212.5.

By determining the restorative material radiodensity one can suggest that a specific type/class of resin/cement was used and subsequently bring an additional layer of evidence in dental identification.
A basic information can be brought by simply comparing cement’s and tooth’s radiodensities; for example Solidex has a lower density (206) while Artclass, Duceram LFC or Targis have a higher radiodensity (231, 220, and 233 respectively) [23, 24].

Conclusions

Although dental implants are widely used in clinical practice, their medical-legal usefulness is somehow limited, mostly due to insufficient data to compare the obtained results with. Even though there are some computerized databases with dental implant information, they are not widely distributed and the data they contained is usually geographically biased, limiting their usefulness as dental implants have a high targeted geographical distribution. A worldwide database, with open access to dental information, including dental implant and cement information is therefore a necessity for better odontological identification.

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References