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FROM THE EDITOR'S DESK

The Pathological Exception: Challenging the Normal-Tooth Bias in Forensic Odontology

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Forensic odontology has long recognised the exceptional value of the human dentition in identification. Teeth can withstand decomposition, trauma and environmental extremes when much of the body has been lost. Tooth morphology, restorations, missing teeth and treatment history can provide valuable evidence for establishing identity.[1–3] But there is another aspect of the tooth that deserves attention: its biology.

Much of forensic casework relies on biological patterns that are sufficiently predictable to permit systematic assessment. Dental age estimation, for example, uses developmental and age-related changes in the dentition, while comparative identification depends on matching anatomical and treatment-related features in antemortem and postmortem records. These methods are well established, but their interpretation is influenced by biological variation, population characteristics and the condition of the tissues being examined.[4–7]

The dentition encountered in actual forensic casework is also rarely a textbook dentition. It may show extensive caries, multiple restorations, periodontal destruction, tooth loss, impaction, developmental anomalies or previous trauma. Cysts, odontogenic tumours, fibro-osseous lesions and other pathological processes may further alter the teeth or surrounding bone. Postmortem changes can add to the difficulty of interpretation.

This raises an important question: what happens when the biological assumptions underlying a forensic method are altered by pathology?

I refer to this as the "pathological exception." The term does not suggest that disease invalidates forensic methods. Rather, it highlights a practical issue: a technique validated under defined conditions may require additional caution when applied to a specimen whose anatomy or biology has been substantially altered.

Dental age estimation illustrates this point. A growing body of literature, including systematic reviews and meta-analyses, has demonstrated differences in performance between methods and populations, as well as considerable heterogeneity in the available evidence.[4–6] Current recommendations emphasise appropriate reference data, careful method selection, estimation of uncertainty and transparent reporting.[7] Pathological alteration is another factor that may need to be considered when interpreting an individual case.

An unerupted tooth, altered root development, extensive periapical pathology, root resorption, hypercementosis, pulp stones or pathological changes in the surrounding bone may not simply be incidental findings. Depending on the method being used, such changes may affect what can reasonably be inferred from the specimen.

This is where the perspective of the oral pathologist can be useful. Oral pathologists are trained to recognise how disease, inflammation, trauma and healing alter the morphology of teeth, bone and soft tissues. These changes can complicate forensic interpretation, but they can also provide information that may otherwise be overlooked. Pathology, therefore, should not be regarded only as a confounding factor.

Consider a patient who has undergone treatment for an uncommon odontogenic tumour, fibro-osseous lesion or another significant maxillofacial condition. Over the course of treatment, the patient may have generated clinical photographs, radiographs,

CBCT scans, biopsy reports, histopathological material, operative notes and follow-up images. If a comparable pathological finding is encountered in unidentified remains, these records may provide an additional source of antemortem information for comparison.

The forensic record of the oral cavity may therefore extend beyond the conventional dental chart. Antemortem records traditionally include dental charts, restorations, missing teeth and radiographs. In selected cases, a pathology record may add another layer of information. A biopsy report documents a diagnosis; imaging documents the location and extent of a lesion; histopathology records its microscopic features; and surgical records document previous intervention. Together, these records may provide useful antemortem information.

This does not mean that an unusual lesion should automatically be regarded as a unique identifier. Most oral diseases occur in many individuals and cannot establish identity on their own. Their forensic value must be considered in relation to prevalence, specificity, quality of documentation and the other evidence available. Nevertheless, pathological findings may provide useful additional discriminative information in selected cases.

This perspective also raises a question about research design. Forensic methods are generally validated under clearly defined conditions, which is essential for scientific rigor. However, where pathology is biologically relevant to a method, future studies could consider including appropriate pathological variables. Instead of asking only whether a method works, it may also be useful to ask under which biological conditions it remains reliable and when uncertainty increases.

There is a similar opportunity to broaden the concept of the antemortem record. Digital radiography, CBCT and three-dimensional imaging have increased the amount of information available for comparison.[8–10] Teeth also remain an important source of forensic DNA when other tissues are compromised.[11–13] At the same time, pathology archives in hospitals and academic institutions contain biopsy reports, tissue blocks, histopathological slides and associated imaging that may, in selected circumstances, provide useful antemortem information.

Using such archives for forensic purposes would, however, require careful consideration of confidentiality, consent, access, chain of custody and regulatory requirements. These issues are likely to become more relevant as pathology records become increasingly digitised.

The same principle applies to emerging technologies. Artificial intelligence is being investigated for dental age estimation, sex estimation and dental comparison, while digital workflows involving CBCT, three-dimensional imaging and automated image analysis continue to develop.[8-10,14] These technologies may offer new opportunities, but their performance will still depend on the biological and imaging characteristics of the material being analysed. Pathological alteration should therefore be considered when such methods are developed and validated.

This also highlights the value of closer collaboration between disciplines. The forensic odontologist brings expertise in identification and forensic interpretation; the oral pathologist contributes knowledge of disease processes and tissue morphology; the oral and maxillofacial radiologist contributes imaging expertise; and the forensic pathologist provides the broader medico-legal context. These perspectives can complement one another when pathological findings are encountered during forensic examination.

Forensic odontology has rightly focused on the durability and individuality of the dentition. It may now be time to give greater attention to the biological history contained within it. The normal tooth remains fundamental to our field, but real forensic specimens are often altered by disease, trauma, treatment and time.

As a journal, we should encourage research that addresses both sides of this issue: when pathology limits the reliability of established methods, and when pathological findings can contribute useful information for identification. The question may not be simply how accurately we can identify a tooth, but how much additional information its history can provide.

Disease, treatment and healing all leave changes in oral tissues. In some cases, those changes may become part of the forensic record.

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