1 Brief introduction to forensic odontology

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1.1 Introduction

According to Keiser Neilsen (1970; cited in Cameron and Sims, 1974), forensic odontology is:

that branch of dentistry which – in the interests of justice – deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of dental findings.

Forensic odontology, or dentistry, has been around for a long time: the identification of Lollia Paulina from her 'distinctive' teeth being as early as AD49, and the first use of bite mark evidence in court in a case of grave robbing in 1814.

The recent attention of the media on forensic 'specialities' featured in various fictional television series has seen an increased interest in this already fascinating subject. This heightened interest, however, has not always been for the right reasons. The use of dental identification in mass fatalities as the more efficient means of identification of severely decomposed bodies has attracted particular attention in natural disasters such as the Boxing Day tsunami in Thailand (2004), the Black Saturday bushfires in Australia (2009) and the Christchurch earthquake in New Zealand (2011). On the other hand, The Innocence Project (see references) has highlighted the 'abuse' and 'misuse' of bite mark analysis as reliable evidence in court; see also Bowers (2006), Pretty and Sweet (2010), Bush (2011) and Metcalfe *et al.* (2011).

To those involved in bite mark analysis research, this 'attack' on the validity of this identification science may not have come as a complete surprise (Clement and Blackwell, 2010; Pretty and Sweet, 2010). Bite mark evidence may be perceived by some in the investigative arena, who are not familiar with this area of forensic odontology, as a science akin to fingerprint analysis or DNA analysis. This is not the case, as was clearly highlighted in the report of the National Academy of Sciences

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(NAS) entitled *Strengthening Forensic Science in the United States: A Path Forward* (2009):

there also are important variations among the disciplines relying on expert interpretation. For example, there are more established protocols and available research for fingerprint analysis than for the analysis of bite marks. (p. 87)

Much forensic evidence – including, for example, bitemarks and forearm and tool mark identifications – is introduced in criminal trials without any meaningful scientific validation, determination of error rates, or reliability testing to explain the limits of the discipline. (p. 107)

The potential for bite mark evidence to be as useful as other forensic science disciplines may exist, but to date the very nature of the evidence renders sound and rigorous scientific research extremely difficult. Numerous publications have highlighted the lack of sound empirical evidence backing the two basic postulates of bite mark evidence and the paucity of rigorous research surrounding this discipline (Bowers, 2006; Pretty and Sweet, 2010; Bush, 2011). This is not to say that sound research has not been conducted over the years, but merely that more of such high-level research needs to come through. Until such a time when 'the barriers to such encompassing and rigorous research to support bite mark evidence' (Pretty, 2006) can be overcome, bite mark analysis needs to be applied to forensic case work with extreme caution.

A forensic odontologist's expertise in bite mark analysis lies in his/her ability to recognise the limitations of bite mark analysis for each individual case (Pretty, 2006). If such caution is applied, the credibility of bite mark analysis will not be irrevocable damage in the long term despite the wrongful convictions documented to date. With the progress of technology in leaps and bounds and 'the willingness to utilise' (Clement and Blackwell, 2010) such technology and science, there will still be a place for bite mark analysis in the investigators' arsenal.

Dental identification has attracted less media attention than bite mark analysis: the methodology is well understood and accepted, and its efficiency, cost-effectiveness and success have been witnessed on numerous occasions (Schuller-Götzburg and Suchanek, 2007; Bush and Miller, 2011; Hinchcliffe, 2011; Tengrove 2011); but that does not mean that it doesn't have challenges to contend with. Improvements in oral care – with an associated reduction of restorations available for comparison – highlight the importance of dental radiography which allows unique anatomical features to assist in establishing a dental identification. Chemical, biological, radiological and nuclear (CBRN) threats call for safe means of collecting dental evidence at the scene, such as cone-beam CT technology. Educating the members of the dental team in the advantages of dental identifications, ideally as early as undergraduate level, is required so as to continue to address the age-old problem of poor ante-mortem dental records which has always hindered the dental identification process. The advent of dental record keeping software addresses part of the problem but has been known to create other minor issues that must be kept in mind.

Mobilisation of individuals from areas of conflict into Europe has increased the requirement for a means to reliably assess the age of a living individual. Discussions

are on-going, particularly in the UK, as to the reliability of dental age estimation of young adults and the ethical implications associated with exposing an individual to radiation for these purposes. In the author's view, the expertise of a forensic odontologist is not reflected in how well he/she mastered the age estimation techniques, but in his/her awareness of the limitations of these methods. Arguably, more important is the skill of explaining clearly to a judge and jury those same limitations and how they may apply to the particular case at hand. Interpreting the results and the statistical background of the methodology used in a way that is clear to the uninitiated is probably the main challenge; more so when various statistical approaches have been applied and then superseded over the years.

1.2 Forensic odontology in the 21st century

Forensic odontology has seen very few major developments over the last 20 years. Changes were mainly related to the assimilation of IT developments into this area of expertise. A very clear example is the improvement in bite mark analysis, previously relying on manual overlay production, while today it is often done with the aid of software such as Adobe Photoshop[®].

Research and development in forensic odontology is hampered by two main problems:

- 1. Ethical issues make adequate research in bite mark analysis, child protection cases and age assessment difficult to conduct.
- Securing funding for such research and development is notoriously difficult as most funding tends to be directed towards traditional medical and dental specialities (Pretty, 2006).

Despite these difficulties over the last few years, through the dedication of those interested in this area and postgraduate student research, the application of forensic odontology is slowly acquiring a more robust backing from rigorous scientific research (Sheets *et al.*, 2012, 2013; Bush *et al.*, 2011). The application of medical devices, software and improved technology to address difficulties in forensic dentistry is seen as a move in the right direction.

The following are some examples of recent and current research:

• *Portable X-ray units*, developed largely with the veterinary services in mind, were brought to the attention of the international forensic dental community by the New Zealand DVI (Disaster Victim Identification) team during identification of the victims of the Boxing Day tsunami in Thailand. One of these units is now on the essential equipment list of the UK DVI team and, coupled with digital x-ray software, it eliminates the need for removing jaws for radiographic examination (both in isolated identifications as well as in mass fatality scenarios), when the only purpose for such removal of jaws is radiographic examination with traditional dental radiographic equipment.

- Mobile multi-slice computed tomography (MSCT) has been part of various research programmes into the application of virtual autopsies in multiple fatality scenarios where CBRN contamination is known or suspected. Concomitant current studies are also assessing whether a similar principle could be applied to dental identification in such scenarios. Cone-beam CT (CBCT) technology provides superior quality dental detail to MSCT and, if applicable, may have the potential to provide post-mortem dental information without the need for direct examination of contaminated bodies.
- *Three-dimensional imaging* for patterned injuries (bite marks) is being researched in various facilities around the world. If developed adequately it could not only eliminate the photographic distortion that affects bite mark analysis but could also increase the versatility of analytical methods and the presentation of evidence in court (Evans *et al.*, 2010; Blackwell *et al.*, 2007; Thali *et al.*, 2003).
- *Computer-generated skin/human body modelling* could resolve the ethical issues with bite mark analysis, providing a means of studying the effects of force, friction, movement, time and tooth features in relation to the reaction of living human tissue, skin being such a notoriously poor impression material (Stam *et al.*, 2010, 2012; Whittle *et al.*, 2008).

However, without the investment by academic departments, funding bodies and research councils, the advance of forensic dentistry will continue to be at a very slow rate.

1.3 Training and experience

There is to date no universally accepted pathway for training to become a forensic odontologist other than the requirement of obtaining a degree in dental surgery and being registered with the national regulatory body to practice dentistry. Different countries have different courses or training pathways, so if someone is interested in getting involved in the analysis of forensic dental evidence he/she should refer to the national organisation for forensic odontology. Table 1.1 lists some of these associations with their respective website (where available). This is not a comprehensive list: new associations/groups will continue to be set up as the knowledge and awareness of the subject spreads.

The International Organisation of Forensic Odonto-Stomatology (IOFOS; www.iofos.eu) aims to liaise between forensic odontology societies on a global basis and should be an early port of call if someone is unable to identify a national association for forensic odontology in their own country.

The national associations will be able to provide advice on the accepted pathway by which a dentist may gain experience as a forensic odontologist/dentist and practise within the legal framework of the country in question following recommended guidelines of good practice. Joining these associations also allows the interested dentist to learn more about the day-to-day experience of being a forensic dentist from those who have been practising for some years. It may come as a surprise to some, how unglamorous the reality is in comparison to the life of forensic specialists portrayed in the various crime dramas aired on the media.

American Board of Forensic Odontology	www.abfo.org
American Society of Forensic Odontology	www.asfo.org
Australian Society of Forensic Odontology	www.ausfo.com.au
Austrian Society of Forensic Medicine (ÖGGM)	www.oeggm.com
British Association for Forensic Odontology	www.bafo.org.uk
Canadian Society of Forensic Science	www.csfs.ca
Croatian Association of Forensic Stomatologists	
Danish Society of Forensic Odontology	www.retsodont.dk
(Dansk RetsOdontologisk Forening)	
Finnish Association of Forensic Odontology	www.apollonia.fi
Flemish Association of Dental Experts	
French Association of Dental Identification	www.adf.asso.fr
(Association Francaise d'Identification Odontologique)	
German Academy of Forensic Odontostomatology	www.akfos.com
(Arbeitskreis für Forensische Odonto-Stomatologie)	
Icelandic Society of Forensic Odontology	
Indian Association of Forensic Odontology	www.theiafo.org
International Association for Forensic Odonto-Stomatology	www.iofos.eu
Israel National Police Volunteer Dentists Unit	
Italy – Forensic Odontology Project	www.proofweb.eu
(ProOF – Progetto Odontologia Forense)	
Netherlands	www.forgen.nl
(Forensisch Medisch Genootschap)	
New Zealand Society of Forensic Odontology	www.nzsfo.org.nz
Norwegian Society of Forensic Odontology	
Polish Society of Forensic Odontology	www.ptos.pl
South African Society for Forensic Odonto-Stomatology	
Switzerland	www.sso.ch
(Forensische Zahnärtze der Schweiz)	

Table 1.1 Forensic odontolog	y/dentistry organisations
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A handful of structured postgraduate degrees exist and have for some time been the entry point for those who express an interest in training in this field. Few as they are, these courses (ranging from Diploma to Masters levels) are becoming even rarer as some of them become victims to lack of funding.

It is the author's and editors' view that, while a structured postgraduate course is an excellent start, it is important for those who qualify to then spend some time shadowing an experienced forensic dentist in the field, ideally on a mentoring scheme. No course, no matter how in-depth and how practical it is, can recreate a case in the field, particularly when it comes to bite mark analysis. The latter requires experience not only in handling and collecting the evidence but also in the analysis itself, due to the variety of scenarios and circumstances that makes each case unique.

As an example, the British Association for Forensic Odontology (BAFO; www.bafo.org.uk) has now established a mentoring scheme whereby dentists who have qualified from a postgraduate degree in forensic odontology and who wish to practise in the field are assigned a mentor in their geographical area. The mentor is someone with some years of experience in the field and, together with the mentee, he/she puts together a personal development plan. This plan will include a period of

observation by the mentee and eventually a period of being under observation during actual cases until both mentor and mentee feel confident that the mentee can practise independently.

The above applies to the practice of forensic odontology in the UK. Different recommendations/pathways will apply in other countries.

1.4 How to use this book

The intention of this book is, in the first instance, to act as an introduction to forensic odontology for the general dental practitioner who has an interest in forensic dentistry and is contemplating practising in the field. It can also be utilised as a companion and reference during practice.

Most chapters will outline accepted and recommended practices and refer to particular methodologies. Where different schools of thought exist, they will be outlined objectively. The reader is advised to use the book as a starting point rather than the one and only source of information, as well as a reference to guidelines of good practice.

It is beyond the scope of the book to cover in full detail areas such as basic dental science, the law as it pertains to practising as an expert witness, mortuary practice, and protection of the vulnerable person. Dedicated specialist texts are available that expand on these subjects.

As noted previously, the editors believe that a book or a series of lectures alone, no matter how comprehensive, are not sufficient to qualify a person to become a forensic odontologist. Such media will provide the information, but the true acquisition of knowledge in the field comes with practical mock scenarios and observation/practice on real cases under the mentorship of experienced practitioners.

The contributors to this book are all experts in their respective fields and understand the needs of the forensic odontologist and how the respective fields interact in practice.

Most of the chapters can stand alone so that the book doesn't have to be read sequentially. However, the ordering of the chapters follows what the editors believe is the correct approach to building up one's knowledge of forensic odontology.

We hope you can enjoy discovering forensic odontology and that this book will encourage you to research more about this field. We welcome any feedback or comments.

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