



John Robson

# Forensic Odontology

**Abstract:** Forensic Odontology (or Forensic Dentistry) can be defined as the branch of dentistry that addresses the proper handling and examination of dental evidence and the evaluation and presentation of dental findings in the interests of justice. In the UK, this usually involves solicitors, barristers, coroners, coroner's officers and the police, and can require appearances and/or presentations and/or formal reports to Crown Courts, Magistrate's Courts, Coroner's Courts and occasionally Civil Courts. Forensic odontologists often work abroad and therefore must be adaptable to the demands and limitations of foreign jurisdictions in relation to international criminal proceedings, suspicious deaths and mass fatality events.

**CPD/Clinical Relevance:** Forensic odontology depends on meticulous record-keeping and accuracy.

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Forensic odontology plays a narrow but important role in the modern forensic armoury. Put basically and simply the discipline can be divided into four areas:

1. Identification (I/D);
2. Bite mark evidence;
3. Age assessment;
4. Archaeological assistance.

In this first article only identification will be discussed.

## Identification

Identification using dental data is not new. Historically, forensic dentistry has played a major role in identification methods. As far back as AD 50 in the time of the Emperor Nero, records show that his mistress's battered body was identified by her teeth. Other important historical incidents such as the 'Paris Bazaar Fire' (1898), the 'Pyjama Girl Case' (1934), 'Dr Buck Ruxton Murders' (1935), the 'Identification of Adolf Hitler' (1945) and the 'Haigh Acid Bath Case' (1949) illustrate the long history of association between forensic investigation and dental evidence. Some of these benchmark cases may be covered in

detail in future articles. But this is not just a process relegated to the long-gone past, forensic odontology continues to play a pivotal role in not only the identification of the deceased, but also the prosecution of the perpetrators, for example Ted Bundy (1974) and Rosemary and Fred West (1994).

Teeth are the hardest tissue in the human body and therefore are the most resistant to trauma, chemicals, decomposition, water immersion and fire and so are invaluable evidence.<sup>1,2</sup> All the restorative materials placed in the mouth by dentists are equally resistant and, in traumatic disruptions to the body, it is the general rule that teeth and restorations enjoy preferential protection compared to almost any other region of the body, therefore tend to survive most successfully. Dental radiographs are the most common radiographs taken and provide a 'snapshot' in time of the dental status pertaining then. Dentistry is therefore of immense value in the identification procedures, not only in criminal cases, but in single cases and mass disasters where body disruption may be extensive.<sup>3-7</sup> Examples where this discipline has proved to be of significant value include the 'Lockerbie Air Disaster' (1988), the 'Asian Tsunami Tragedy' (2004), the 'London Bombings' (2005), the 'Dhow Boat Disaster' (2006), the 'M5 Motorway Crash' (2011), the 'MH17 Air Crash' (2014) and the recent atrocities in Brussels and France (2016). In the very

recent 'Grenfell Tower Tragedy', dentistry played the major part in the identification procedures. Despite the advent of DNA profiling and recent advances in DNA science, dental identification still provides a quick, economic and reliable way to identify the deceased, provided that comparable ante mortem (AM) records are available. However, it should be remembered that the other identification methods also require AM information and data for comparison.

In the largest ever forensic identification investigation (Asian Tsunami 2004), dental identification played the major role, despite there being a mix of bodies of both international and local origin, although the locals, for many reasons, had little or no ante mortem dental information. However, most bereaved relatives had photographs of their loved ones and, if any of these showed any peculiarities of the anterior teeth, they proved extremely valuable. Accordingly, despite no dental records being available, dental identification was still accomplished.

Visual identification in such mass fatalities is not recommended – in fact must be positively avoided as, even with a complete body with relatively little external trauma or decomposition, mistakes may often occur.<sup>8,9</sup> In the emotive state suffered by the family and friends and their urgency to find their loved ones, misidentifications occur. Once the death of

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**Figure 1.** One of many photos placed outside the mortuary in Colombo in the hope that victims could be visually identified!



**Figure 2.** 'MH17 Air Crash'.

a loved one has been accepted, there may then be demands for an immediate return of the body, which is often not possible because the consequences of a misidentification can be great – if the wrong body is returned to the wrong relative then there is every likelihood that somewhere else another body has been

identified (and returned) incorrectly.<sup>10</sup> This has legal implications for insurance, inheritance and remarriage, etc and causes immense psychological problems for the next of kin. Identification mistakes have occurred in many situations, including Lockerbie, the Asian Tsunami, both in Sri Lanka and Thailand,

and the Luxor terrorist attacks, when one family went through the funeral process only to be informed later that the wrong body had been returned to them. One can only surmise the mental trauma that was caused.

There are many factors which make visual identification unreliable and difficult (Figure 1) including:

- Damage to the body;
- Effect of the viewing on next of kin;
- Memory of the deceased.

#### **Damage to the body**

Examples of damage to the body include bloating after water immersion, fire damage, decomposition, body fragmentation, etc.<sup>11</sup>

#### **Effect of the viewing on next of kin**

Some are so keen to find their loved one that they will unconsciously misidentify in order to find a body, in order to alleviate the stress and dismay caused by 'not knowing' and they can then focus their grief on something.<sup>12,13</sup> The opposite can also occur where there is denial, where they cannot accept the death and will refuse to acknowledge the body as their next of kin. They are involved in a unique and sometimes frightening situation which most of us, thankfully, have not, or will not have to, endure at a time when they are emotionally affected.

#### **Memory of the deceased**

It may be that some time has elapsed since the person was last seen and, obviously, in different circumstances. Physical attributes such as the effects of ageing, head hair, facial hair, wearing of glasses, may have changed the remembered appearance.

### **Classification of mass disasters**

Mass fatality incidents are most often classified as:

- Closed;
- Open;
- Combination.

#### **Closed (Figure 2)**

This is where there is a list or passenger and crew manifest so that the





Figure 3. 'Shoreham Air Display Crash'.



Figure 4. 'Lockerbie Air Crash'.

victims can be checked with ante mortem information gleaned from the families. This would appear to make things simple, however, the author has been involved in situations where the numbers do not tally and later were explained by an extra pilot on the flightdeck jump seat, a small child who didn't need to book a seat, people travelling with a false identity, etc, etc. Recent examples of closed incidents are 'MH17 and German Wings Air Crashes' and the 'Sinking

of the Cruise Ship *Costa Concordia*.'

#### Open (Figure 3)

This is where there is no list and the investigating authorities have to wait for the victim's loved ones to report him/her missing. This can be a more difficult and more time-consuming situation. Recent examples of this include the 'Shoreham Air Display Crash' and natural disasters like floods and earthquakes.

#### Combination (Figure 4)

Here we have the situation where we have a mix of open and closed. The classic example of this was the 'Lockerbie Air Crash' where a B747 jet carrying 259 passengers landed on the town of Lockerbie and killed 11 on the ground.

#### Search and recovery

In this vital initial stage of operations it is essential that all available information is collected with correct documentation. Teeth are often lost from the body due to the trauma of impact, particularly the lower straight-rooted anteriors, and these may be of particular value to the odontologist. Usually, the odontologists are not directly involved with this, thus it is important that police and recovery teams have a basic knowledge of the morphology of human teeth and associated structures, such as dental crowns, bridges, dentures, etc and are able to differentiate these from other artefacts. We always suggest that, if there is any doubt, the article should be examined by the odontologist (Figure 5).

#### The procedures involved in the making of a dental identification (I/D)

The odontologists in a disaster situation become involved in all the identifying procedures and these can be summarized as follows:

1. Collection of ante mortem (AM) data;
2. Collection of post mortem (PM) data;
3. Reconciliation (or comparison) of this data;
4. Presentation to I/D commission;
5. Presentation to I/D board/coroner, etc;
6. Release and (if abroad) repatriation.

#### Collection of ante mortem data

All the scientific methods of identification (ie fingerprints, DNA and dental) almost always involve the comparison of ante mortem and post mortem data and thus rely on the quality and quantity of the AM data. Dental data is usually collected by the police family liaison officers (FLOs) and is available from numerous sources, which include family and friends, dentists, dental clinics, specialists, doctors, workplace colleagues, hospitals, etc. It is important that they are instructed to ask the professionals for all dental records, including



**Figure 5.** Typical recovery material: luggage, aircraft parts, human and animal remains, from 'Air Afrique Airways Accident' (2010).



**Figure 6.** Bleaching trays that were used by the author in the successful i/d of a victim in the 'Dhow Boat Disaster' (2006).

charts, radiographs, documents, invoices and letters, etc and any dental items, such as clinical photographs and models.

The FLOs are also directed to ask the family and friends for any dental items they may have such as toothbrushes, (DNA source), extracted teeth, mouthguards, bleaching trays (Figure 6) and also, as mentioned above, smiling photographs to show anterior teeth.

In practice, and unless the disaster is small, all the dental data is assessed, interpreted and collated by a team of odontologists working as the 'home team', which, paradoxically, may not be at home! This is a vital part of the process as dental records are sometimes out of sequence,

written in another language or system and use different abbreviations. These are then collated and a final composite AM record constructed. Occasionally, it is necessary for an odontologist to contact the dentist personally to clarify matters, especially if the records are in a foreign language or a charting system unfamiliar to the AM odontologist (eg Chinese, Japanese, Thai, etc). Once collated and assembled, the records are copied and retained at the home base. The originals and collated records are sent on to the field site, mortuary or information centre, both in electronic and in hard copy form. There are now computer systems which aid the comparisons and the home team may also enter the records directly into such a program.

The information is then reviewed by the AM odontologist(s) and collated and transcribed onto the Interpol International forms. This is also entered into a comparison computer program called *Plassdata*. Our bywords for AM collection are '*Too much information is better than too little*'

The importance of correct and accurate dental charting and recording by the GDPs and their staff cannot be over-emphasized. We owe it, ethically and morally to our patients to undertake this. In fact, all that is necessary is that, when the patient is first seen as a new patient, a good record is made – in this way, we have a good 'baseline chart' and, for future check-ups, this information can be carried forward.

The author recently had a high profile disaster case in which all present and

missing teeth were charted but, despite there being restorations in the upper arch, only those in the lower arch were recorded! However, as there were only a small number of victims, this did not hinder the I/D – it only made things a little more complex.

## Dental charting

There are well over 100 methods of tooth charting and, although attempts have been made for many years to come to an international agreement to have one global, universal system, – Federation Dentaire International (FDI) – this has not yet been completely successful. Listed in Figure 7 are some of the more common systems used and an example in each method of how the upper left first premolar tooth is written. (To avoid confusion only permanent teeth have been noted, but the deciduous dentitions follow similar patterns).

## Collection of post mortem data

In the mortuary, the bodies and body parts will be examined by the PM odontology team and as much information as possible recorded, even if at the time it does not always appear to be significant. One must bear in mind that sometimes the body will only be available for a single examination and a second chance to gain information may not be forthcoming!

In the mortuary there is usually a 'flow' system where the body is examined in turn by the many disciplines involved. In the dental section the dentists usually work in teams of two – one 'clean' (doing the recording and assisting) and one 'dirty' (undertaking the actual examination). In the ideal situation, there is also a DCP on hand to assist. The examination in the mortuary is more difficult than in the dental surgery – the lighting may not be as good so sometimes it is difficult to discern tooth-coloured fillings, there is no 3-in-1 syringe for debridement and there is often decomposition and infestation. The procedural format is usually decided in a briefing by and with the Dental Identification Manager. It basically consists of a detailed examination starting by checking the unique body/body part number and any associated paperwork, photographs, cleaning of the teeth, replacement of any loose teeth, photographs again, radiographs in accordance with the set protocols, and then a detailed



<b>FDI</b> 18 17 16 15 14 13 12 11 / 21 22 23 24 25 26 27 28 48 47 46 45 44 43 42 41 / 31 32 33 34 35 36 37 38	24
<b>Palmer's/Zigmody</b> 8 7 6 5 4 3 2 1 / 1 2 3 4 5 6 7 8 8 7 6 5 4 3 2 1 / 1 2 3 4 5 6 7 8	/4
<b>Haderup (Sweden)</b> 8+ 7+ 6+ 5+ 4+ 3+ 2+ 1+ / +1 +2 +3 +4 +5 +6 +7 +8 8- 7- 6- 5- 4- 3- 2- 1- / -1 -2 -3 -4 -5 -6 -7 -8	+4
<b>Some Other European</b> D8 D7 D6 D5 D4 D3 D2 D1 / G1 G2 G3 G4 G5 G6 G7 G8 d8 d7 d6 d5 d4 d3 d2 d1 / g1 g2 g3 g4 g5 g6 g7 g8	G4
<b>In Papers</b> UR8 UR7 UR6 UR5 UR4 UR3 UR2 UR1 / UL1 UL2 UL3 etc LR8 LR7 LR6 LR5 LR4 LR3 LR2 LR1 / LL1 LL2 LL3 etc	UL4
<b>Holland</b> sdM3 sdM2 sdM1 sdP2 sdP1 sdC sdI2 sdI1 / sgI1 sgI2 sgC etc diM3 diM2 diM1 diP2 diP1 diC diI2 diI1 / giI1 giI2 giC etc	sgP1
<b>Universal (USA)</b> 1 2 3 4 5 6 7 8 / 9 10 11 12 13 14 15 16 32 31 30 29 28 27 26 25 / 24 23 22 21 20 19 18 17	12
<b>Other USA</b> 16 15 14 13 12 11 10 9 / 8 7 6 5 4 3 2 1 32 31 30 29 28 27 26 25 / 24 23 22 21 20 19 18 17	5

Figure 7. Some of the more common systems used.

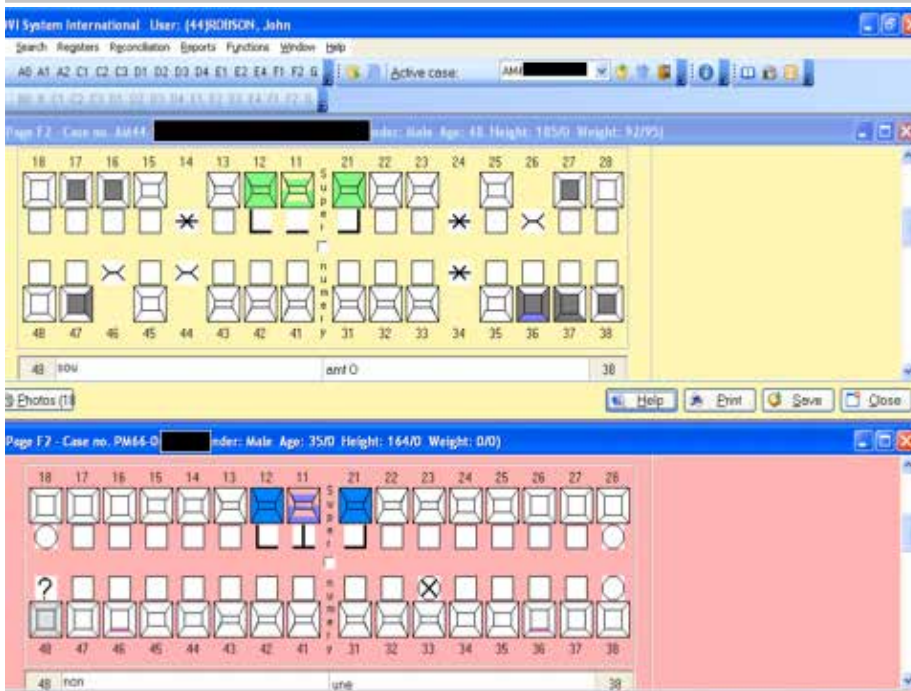


Figure 8. An example of the Plassdata system (matching on an anterior bridge).

full mouth examination and charting. At this stage, an age assessment may be made, and, after permission from the coroner or the equivalent abroad has been obtained, a tooth

can be extracted for DNA matching. This is ideally an unfilled (virgin) molar tooth which is an excellent source of DNA. At the end of the examination any tissue, dentures and

bridges are replaced and the mouth and jaws restored (as much as possible) to a dignified appearance.

If a computer matching program is to be used, all the post mortem details will be entered onto the system. This includes the information pertaining to charting, photographs, noted anomalies, X-rays, age evaluation, etc.

### Reconciliation

This is the process of comparison of dental ante mortem and dental post mortem information. In any incident that involves more than one nationality for the deceased, Interpol procedures are most often adopted and this involves the use of standardized international recording forms, which are regularly updated and modernized. Conventionally, the ante mortem form is written on a yellow background while the post mortem form is on a pink background.

In a very small incident, the reconciliation can often be done without recourse to the international forms and, in these incidents, most forensic odontologists will follow their own protocols and procedures. However, in a major disaster with a large number of casualties, standardization for data recording in conjunction with computer programs is important and, indeed, vital. The computer program (*Plassdata* – Figure 8) has been refined over recent years and is now the choice for all large incidents. However, as with any computer program, its success depends upon the quantity and particularly the quality of the input information.

Suggested matches between ante mortem and post mortem information are identified by the program and must then be examined in detail by the odontologists and any discrepancies must be explained before a tentative match can be accepted.

An identification is then

categorized in one of five ways:

1. Established (beyond reasonable doubt or [as the author likes to use...sure]);
2. Probable (very likely);
3. Possible (no discrepancies but insufficient unique information to confirm identity beyond reasonable doubt);
4. Excluded (the information precludes a match);
5. Insufficient information to establish any of the above conclusions.

Although on first sight all except

'established' (Group 1) could be perceived as being of limited value, this is in fact not the case. 'Probable' and 'Possible' matches are useful in that they can be used to focus other disciplines (eg fingerprints and DNA) to prioritize checks. 'Excluded' means that the particular match can be removed from the system and not used again. With an 'established' identification, the ante mortem and post mortem hard copies are checked and compared again and, if all is in order, the files are sent to the identification commission for further processing. The comparison details are recorded in such a way that each tooth can be compared, the result detailed and any discrepancies explained.

## Presentation to the identification commission

The prime functions of the identification commission is to review all the evidence available and decide whether the identification is in fact established. The constitution of this official body depends on the location and jurisdiction of the legal authority. In England and Wales, the coroner has complete control and decides who is to be present. Commonly, it is the team leader from each discipline who is present to allow any discrepancies to be discussed, explained and further explored. This means that the senior fingerprint expert, senior DNA expert, senior odontologist, a senior investigating police officer (to present the physical evidence) and the pathologist should be present. However, this is at the complete discretion of the coroner.

## Presentation to the identification board

In some countries and situations, after the identification commission has met and reached a conclusion, one representative (depending upon the primary identification method) will present the evidence to the coroner or equivalent in a court of law and then the final paperwork is completed. This was the procedure adopted in Sri Lanka for the 'Tsunami Victims in 2005'.

## Release and repatriation

Before release to the relatives and, if necessary, repatriation, the coroner must be satisfied regarding the identification and ensure that all the necessary paperwork is in

order. Repatriation can be complicated and usually involves specially sealed coffins and sealed body bags, numerous tags and export and import licences. In an ideal world, it is better to make all the identifications before any bodies are released – however, in practice, especially in large disasters, this rarely happens due to the many conflicting pressures. A final check is sometimes instigated just to make sure everything is in order and the right body is with the correct paperwork. The author remembers one or two occasions abroad in a large mass fatality incident where this was not correct and only the quality assurance check by the odontologists avoided an embarrassing error.

## Summary

Forensic odontology is a valuable tool in the identification of unknown remains and for this reason it is critical that experienced and forensically qualified dentists are deployed. There is a DVI (Disaster Victim Identification) list of suitable personnel held by the police and a 24/7 call-out system which is organized by the three UK DVI Dental Identification Managers (DIMs). They are all members of the British Association for Forensic Odontology (BAFO), usually work in pairs, must be available at short notice and be familiar with ante mortem, post mortem, reconciliation and other mortuary procedures, be aware of health and safety considerations, working protocols, legal and investigative requirements and are prepared to write legal reports for later use in any court proceedings. All of this hinges on a sound and detailed knowledge of the anatomy of the dental and associated mouth structures. In a DVI team every member must be prepared to respect the requirements of each and every discipline, be able to work together as a close network in difficult and intense environments and ensure that, at all times, the responsibilities to each other, and ultimately to the courts, are observed to the highest degree of professionalism. In the team there is usually one DIM and team leaders for each section of the work. Often this work carries high profile media interest and intense pressure for an early result from the families, which adds an extra dimension of stress to what may already be a very difficult working environment and is also compounded by security concerns and restrictions when operating in a military environment or conflict zone. All of this work must be directed

towards achieving unbiased and objective evidence whilst ensuring that the ultimate goal is achieved of identifying the deceased with dignity and respect so that they may be returned to their loved ones, safe and secure in the knowledge that the correct identification has been achieved.

Referring to bereaved families: 'At the worst time in their lives the very least we can do is our very best.' Mr D Mc Garry, UK National Advisor for Family Liaison Officers.

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