Forensic Podiatry: A Review

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Introduction and Recent Developments

Forensic podiatry has been considered to have been available as an area of specialist practice for many years (Norfolk, 2004). The first literature from 90 years ago was however idiosyncratic (Gerard, 1920) and later literature was presented without supportive evidence being demonstrated within the available publications (Lucock, 1967; 1979; 1980; Muir, 1935).

It can be suggested therefore that it is only in the recent past that forensic podiatry has become formally established through research now being published in the field (Kennedy, 2003; 2005a; b; Sanger and Vernon, 1998; Vernon, 1994; Vernon et al., 1998; 1999; 2003; 2004) and with the discipline having recently been recognised by regulatory and professional bodies (Polski, 2007; Vernon and Kelly, 2006).

Modern day forensic podiatry has been defined as “the application of sound and researched podiatry knowledge and experience in forensic investigations, to show the association of an individual with a scene of crime, or to answer any other legal question concerned with the foot or footwear that requires knowledge of the functioning foot” (Vernon and McCourt, 1999). While the definition covers all legal applications of podiatric expertise, the popular understanding of forensic podiatry is in relation to practice in the criminal context.

Recent developments in forensic podiatry have been catalysed by various research projects, which commenced in the early 1990s in an attempt to test the viability of forensic podiatry approaches (Sanger and Vernon, 1998; Vernon, 1994), to clarify areas of uncertainty in relation to podiatric understanding in a forensic context (Vernon et al., 1998; 1999; 2003; 2004) and to test levels of individuality of features which would be use by forensic podiatrists in their work (Kennedy, 2003; 2005a). The publications which accompanied these projects led to requests for assistance in forensic identification work (McCourt, 2000; Vernon 2005; 2007). These in turn led to additional publications which had the sole purpose of raising awareness of the discipline and what it could offer to human identification (DiMaggio, 1995; 2005; Gorman, 1997; Kippen, 1996; Lesce, 1992; Vernon, 1995; 2000a; 2001; 2006). Reports in the media of successful applications of forensic podiatry work also followed (Buncombe, 2000; Miles, 2001).

As requests for case assistance from forensic podiatrists increased, concerns developed that practice was at that time unregulated. Discussions with the Council for the Registration of Forensic Practitioners (CRFP) commenced with a view to the CRFP recognising and regulating the work of forensic podiatrists in order to maintain standards and protect the public from poor practice. The CRFP recognised the needs of forensic podiatrists, and following the creation of standards of competence for the discipline, registration commenced on 1st October 2006 (note: CRFP is now disbanded).
Before registration with the CRFP became available to podiatrists, the only human identification organisation to recognise forensic podiatry was the British Association for Human Identification, “a forum for the discussion and promotion of subjects of a common interest to of all professions that operate within the domain of human identification” (BAHID, 2007). Following regulation by the CRFP, in July 2007 a case for the recognition of forensic podiatry was taken to the Board of the International Association for Identification (IAI) - the oldest and largest professional association for persons involved in forensic identification.

The Board formally approved the instigation of a Forensic Podiatry Sub-Committee within its’ structures (Polski, 2007) paving the way for international development of the discipline with regular international conference tracks, and the potential to devise certification programmes and internationally relevant standards of practice. With this development came the recognition within the forensic science disciplines that podiatrists had sought for a number of years in their drive for acceptance.

Proceeding in tandem with these developments were slowly gathering educational initiatives. These commenced at a very basic with the inclusion of single lectures on forensic podiatry within undergraduate courses in various schools of podiatry. The effect was that a number of podiatry students became interested in the subject area and subsequently undertook forensic podiatry projects for their required final year projects. As interest in the subject spread, podiatry MSc students similarly completed dissertations on forensic podiatry topics (Pavey, 2004). Staffordshire University took this one stage further, with a newly developed post graduate certificate in diagnostic and therapeutic footwear studies containing a portfolio-assessed study module on footwear identification aspects of forensic podiatry. The University is further planning a post graduate diploma and masters degree in forensic podiatry, using the certification programme as a platform for developing further studies in this field.

Interest in forensic podiatry developed outside the profession and again, educational opportunities were created to raise an awareness of the discipline and what it could offer the field of identification. As in the purely podiatric educational initiatives, single lectures are now given to some undergraduate forensic science students and to others studying forensic human identification at masters degree level, again with some evidence that students had been stimulated to undertake research for their required academic projects (Reynard, 2005). In response to gathering interest in the subject, the Worshipful Society of Apothecaries Diploma in Forensic Human Identification began to consider forensic podiatry matters within its’ syllabus and subsequently invited forensic podiatrists to lecture on their subject and to join their examiners panel, setting exam questions and optional thesis topics on forensic podiatry matters. There has therefore been gathering interest in forensic podiatry from within the podiatry profession, from closely related forensic science professionals and from others in the field of human identification who may wish to use the services of a forensic podiatrist in their work.

Areas of Practice
(With Evidence-Based Considerations)

There are currently four main sub-specialties within the scope of practice of forensic podiatrists and these cover analysis and identification involving:

- Podiatry treatment records
- Bare footprints
- Footwear
- Gait patterns (from Closed Circuit Television (CCTV) footage)
These will now be considered and reviewed in turn.

1. Analysis and identification involving podiatry treatment records

Technique Podiatrists keep detailed records of the patients they treat and of the treatments carried out on these patients.

The records themselves contain personal information (name, address, contact details), relevant medical history, a record of the individuals foot type, pathologies identified including the functional, structural and superficial pathologies of and affecting the feet and any treatments carried out on the individual by the podiatrist (Doney and Harris, 1984; Merriman and Tollafield, 1999; Vernon, 2006). Within these records, it is the information held by podiatrists that refers to the status of the foot, which can be used in identification. Of particular value is information relating to the individuals foot type (e.g. the presence of pes cavus), of structural pathologies (e.g. hammer or mallet toes) and of the form, site, type and size of skin lesions affecting the foot (e.g. sites of corn and callus).

Podiatry record card identification has been seen as beneficial in the identification of the deceased, with the identification technique being of particular value when the lower limb has been separated from the body, or when other features of the body have been rendered unidentifiable, for example through burning. The technique has been used in isolated cases where for example an elderly person known to have received podiatry care has gone missing and an unidentified body has later been found (Cheshire, 1995 (pers. comm.), although its’ greatest potential value has been envisaged in mass disaster identification situations (Doney and Harris, 1984; Vernon, 1994).

Evidence base Through a series of publications, the identification of unknown deceased persons from information contained in podiatry record cards was originally suggested by Dr. Ivor Doney (1984 etc). Doney’s papers did not offer research evidence to verify the effectiveness of the technique, however this was not the purpose of his work; that being instead to raise awareness amongst the identification community of this novel suggestion. Basic research then followed in the 1990s, when Vernon (1997) and later Sanger and Vernon (1997) investigated the potential of podiatry record cards in identification. Here, the proportion of the population who would be expected to have a podiatry record was initially considered. This was then followed by an investigation of the success of podiatrists in undertaking judgement-based mock identifications of un-named individuals from anonymous podiatry records.

The key findings of this project were that at that time, approximately 7.25% of the UK population would have a podiatry record (suggesting that there were sufficient numbers of the population with a record for the technique to be viable) and that when asked to provide a simple identification judgment, podiatrists had a success rate of between 85% and 97% in relation to the proportion of correct judgments made (Vernon, 1994). At a later stage, a strength scale was introduced into the technique and it was found that when allowed different levels of opinion, where podiatrists made an identification judgment with absolute certainty these conclusions were correct 100% of the time, and 56% of all judgments made in the tests were done so with absolute certainty (Sanger and Vernon, 1997).

To date, these two studies have been the only recorded research undertaken into identification from podiatry treatment records. While further suggestions were made for follow-up work, these have not been followed up. Although the last of these two research projects was undertaken over 10 years ago, because of the basic nature of these studies in conjunction with the non-existent follow-up for further development purposes, the technique can still be seen as being in its’ infancy.
2. The description and identification of barefoot prints

**Technique:** The use of bare footprints has been considered for many years as a means of identification (Kennedy, 1996; Muir, 1935). Here, the physical dimensions of the unknown footprint morphology can be compared with that of the associated foot for identification purposes. It is also possible to identify the presence of a number of foot pathologies or individual characteristics of the foot from the footprint and use these in the identification process (DiMaggio, 2005). The task involved in identification from bare footprints is firstly that of describing the footprints under consideration, then of comparing known and unknown footprints together. A number of methods have been described for this purpose (Vernon, 2006b) although three predominate.

The first of these is the Gunn method, which uses a series of measured lines drawn to connect various identifiable landmarks of the foot (e.g. back of heel to tip of 1st toe - Vernon, 2006b).

The second is the optical centre method - a variation on the Gunn method, developed by the Royal Canadian Mounted Police (RCMP). In this, a concentric circle is placed into the position of best fit within a defined feature of the footprint (e.g. the second toe impression), the centre of the circle is pinpointed, with lines then being drawn to connect this point with similarly defined positions situated elsewhere within the footprint (Bodziak, 2000; Kennedy, 2005a; Vernon, 2006b).

The third method is the overlay method, as devised by the Forensic Science Service (Facey, 2005, pers. comm.). Here, the outline of a known footprint is traced and when this is placed over an unknown footprint, a comparison of the overall position and features of the two prints can be made. Such features can include the shape and position of the toes, the shape of the leading edge of the ball of the foot and minor detail such as crease lines, areas affected by callus and small variations in contour of the outside edge of the print (Vernon, 2006b).

This area of identification is not the exclusive domain of the forensic podiatrist, with other disciplines having legitimate claim to involvement in barefoot print identification, including anthropologists and forensic marks examiners (Borkowski, 2002; Kennedy, 1996; Laskowski and Kyle, 1988; Massey, 2004; Robbins, 1978). The podiatrists’ particular expertise in this area is in the identification of foot pathologies (e.g. hallux valgus, retracted toes), foot type, and individual characteristics of the foot (e.g. toe formulae) from the footprint as well as being able to consider and explain differences between compared footprints, where a footprint has been amended by function. In practice, however, the podiatrist would use the same methods for initial description and comparison of the footprint as other disciplines involved in this area.

**Evidence base:** There have been a number of publications which have considered the individuality expressed by barefoot prints (Bodziak, 2000; Cassidy, 1987; Kennedy, 1996). These culminated in a major study by the RCMP, in which a database of 24,000 footprints was collected, interrogated and interpreted with a view to demonstrating the uniqueness of footprints (Kennedy, 1996; 2005a; b; Kennedy et al., 2003). The work has not been exclusively for podiatrists, but instead is of value to all disciplines involved in footprint identification. Each specialty is able to use the findings from this research for its’ own purposes, particularly the considerations of individuality expressed by footprints.

Other work has been undertaken to consider dimensional ratios of footprints (Chockalingham and Ashford, 2002; Laskowski, Kyle, 1988), and to explain features of footprints available for comparison purposes (DiMaggio, 2005; Kennedy 2005b; Massey, 2004; Qamra et al.,...
1980; Vernon, 2006) and surveys have taken place previously to indicate the population incidence of various features of the foot, some of which may be apparent from footprints (Brodie et al., 1986; Clarke, 1969; Greenberg, 1994).

While the work on footprint individuality has been invaluable in providing a baseline of understanding, the value in relation to “real-world” situations is more limited. This is because the Canadian study necessarily centred around footprints collected under standardized conditions, while those encountered in crime scene situations are subject to the effects of many variables (e.g. alternative function, slippage), which to date are not fully understood. Further work is currently taking place to provide improved understanding of variable effects on footprints, which should enhance the value of footprints in identification.

Although population surveys do exist in relation to a number of pathologies and individual characteristics of the foot, given the high number of such features, these surveys are relatively limited. While podiatrists have a track record of being able to identify such features in criminal investigations (Vernon, 2007a; b), the value of their contribution can be enhanced considerably with much wider implementation and publication of foot surveys. While the number of surveys available remains limited, forensic podiatrists need to be careful to work within the relatively limited boundaries of current understanding.

3. Analysis and identification involving footwear

Technique: The consideration of footwear in relation to criminal identification has again been around for many years (Abbott, 1964; Bodziak, 1990; Cassidy, 1987; Lucock, 1967). It is an area of identification in which forensic pathologists (Smith, 1959) and marks examiners (Bodziak, 2000) have also claimed expertise, although many aspects of footwear identification fall within the traditional realm of the forensic marks examiners, who use accidental damage features on the shoe outsole in order to link a shoe with a scene of crime. Podiatric involvement relates to techniques of identification involving the wear features of shoes, including foot impressions, wear and creasing of the shoe upper and wear of the shoe outsole.

Anecdotally, podiatric involvement in footwear identification does appear to be increasing. As criminals are becoming more forensically aware, their alibis are demanding that not only should the shoe be linked to the crime scene, but also that the perpetrator of the crime should be linked to the shoe. It is in this task that the skills of the forensic podiatrist are required, although some forensic marks examiners are also working in this highly specialized area (Facey et al., 1991; 1992a; b; 1993; Giles and Vallandigham, 1991; Gordon and Buikstra, 1992). The task of linking an individual to a pair of shoes is centred around the foot impression within the shoe, with the techniques used in barefoot impression comparisons (Gunn, optical centre and overlay methods (Vernon, 2006b) being utilised. When dealing with footwear, additional factors need to be considered, which relate to the variables introduced by the wearing of shoes, where the foot and shoe have interacted together and one has influenced the other (Vernon, 2006a).

The foot impression within the shoe is something entirely different than the barefoot impression, with the barefoot impression being formed by a single contact of the foot with the ground, and the foot impression within a shoe being formed by contact with the foot during the entire period that shoe has been worn. Because so many additional variables are introduced through the wearing of a shoe, it is important that like-with-like shoe comparisons are made in the identification process (e.g. compare a training shoe with a training shoe, a boot with a boot etc). The podiatrists particular skills in this area of identification centre around their knowledge
of the foot/shoe interface and the effects of both this and foot function on the contained foot impression.

In addition to considering the foot impressions found within shoes, various other wear features can be used when examining footwear for identification purposes. These include impressions, distortions, and crease lines of the shoe upper. These features have been considered clinically by podiatrists for many years (Gibbard, 1958a; b; Hanby and Walker, 1949; Lorimer et al., 2001; Ware, 1920) and this knowledge enables podiatrists to consider the observed wear features in combination, in order to provide a more complete picture of an individuals’ foot status for identification purposes. Similarly, wear patterns of the shoe outsole may also have some value in identification, when these patterns are repeatable and unusual and when considered in combination with other wear features of the shoe, some limited form of interpretation may be possible, although this should be approached cautiously (Bodziak, 2000; Vernon et al., 1998; 2004).

**Evidence base:** While the examination of wear features of shoes, including foot impressions formed on the shoe insole/ sock liner, is one particular strength of forensic podiatrists, the supportive evidence is somewhat limited. Although many podiatrists use shoe wear features within their clinical examinations, this knowledge has tended to be of the tacit intuitive type of professional understanding as opposed to comprehensively researched propositional knowledge (Vernon, 2000a). Research on forensic podiatry aspects of shoe wear has been limited in more recent times to consideration of the shoe outsole wear. Ironically, this research has done more to limit the use of outsole wear in identification through showing its’ limitations, than it has to enhancing the use of outsole wear patterns in identification (Vernon 2000; Vernon et al., 1998; 2004). The effect of this work has, however, been to improve the understanding of factors relevant to outsole wear pattern formation, to demonstrate the need for caution in using outsole wear patterns in identification through the feature being unstable in terms of repeatability, and to destroy myths surrounding outsole wear patterns, thereby reducing the potential for error when considering their use in identification. Also of value in considering footwear for identification purposes are various databases and population data on foot and shoe size (SATRA, 1999), allowing proportions of the population who are wearing footwear of a particular size to be considered from an identification perspective.

Footwear examination for identification purposes is therefore particularly suited to podiatrists with forensic expertise. There is again the potential for much more research to be done in this area, thereby increasing the value that footwear has in identification.

4. **Forensic Gait Analysis**

**Technique:** Forensic gait analysis is a relatively new application of podiatry knowledge in forensic identification. The first documented use of forensic gait analysis in identification was in July 2000 whereby the identification of the perpetrator of a jewellery theft was assisted by the recognition of a ‘bow-legged’ style of gait in the individual concerned, which it had been estimated that only 5% of the population would exhibit (Buncombe, 2000; Miles, 2001).

Computer scientists are also developing work in this area, specifically in the use of gait as an automated biometric, in which the computer recognises and compares shape and movement in the identification process (Nixon et al., 2006). This differs from the work of podiatrists in this field, with podiatrists not being concerned with modelling of the shape and dynamics of the overall moving body, but instead with the specific recognition of known structural and functional pathologies of the foot and lower limb as captured during movement. In forensic gait analysis, the podiatrist would
examine recordings of events which have been captured on CCTV footage, identify any fixed or functional pathological features of interest displayed by the individuals, then compare these with either the individuals themselves, or with other recordings known to be of the individual concerned. Where common features are identified, these would be compared either with published data on the incidence of the feature within the population considered, or alternately where this does not exist, with population data which would then be collected specifically for immediate comparison purposes.

**Evidence base:** While computer engineers have subjected their own involvement in forensic gait identification to research and development, this has not yet taken place in relation to forensic podiatrists gait recognition techniques. In some ways, this is justifiable, because the forensic podiatrists’ involvement is more basic and does not involve the complexity required in developing automated biometrics systems. Forensic podiatry approaches simply require the recognition of known features from CCTV recordings, using the clinical diagnostic and recognition techniques which the podiatrist would employ during the course of their day to day work. Inter-observer reliability tests would however be useful in verifying the repeatability of the observations made. The technique also relies on the existence of comparative survey data, whether previously published, or collected to address the needs of a particular case. In this sense, there would be anticipated benefits in undertaking further surveys of such conditions to create a much larger and available knowledge base to assist with this work.

**Conclusions**

Awareness of forensic podiatry in identification has now started to spread and the recognition of the specialty within the CRFP and the IAI should catalyse further interest, involvement and awareness and the further development of professional practice in the field. In the past 20 years, the profession of podiatry in its’ widest sense has changed from one which had a weak research foundation and in which many of its’ practitioners did not recognise the value of research findings within their practice, to one which has been working hard towards evidence-based practice throughout all its’ sub-specialties. The recognition of the need for research was reached at an early stage in the practice of forensic podiatry.

Because of the very specialised nature of forensic podiatry and the limited number of podiatrists practising forensic identification, research in this particular field has however been limited. This peculiar balance of strong research awareness within the context of limited research being available upon which to base this area of practice can be seen as having restricted forensic podiatry practice to date. Although forensic podiatry research is taking place, because of the limited number of individuals who have been involved in this work, this has consequentially been slow. With the recent developments in forensic podiatry, coupled with rapidly increasing interest in forensic podiatry practice, this may now change with the discipline becoming more firmly established as this takes place.


Borkowski K., “Factors influencing the direct identification of a human being on the basis of footprints”, Presented at the 16th IAFS Conference I Montpellier, 2-7 September 2002.


Facey O.E., Personal communication, 2005.


Pavey C., A Delphi study of forensic podiatry practice, MSc dissertation, University of Brighton, 2004


Reynard A., Shoe size estimation from metatarsals, MSc dissertation, Bradford University, 2005.


SATRA (Shoe and Allied Trade Research Association), Proportion of the UK population with a given shoe size, 1999.


Vernon W., “Forensic Podiatry”, Society of Podiatrists and Chiropodists Virtual Learning Centre, 2000a


Ware E.D. "Diagnosis of shoe wear; its cause and results", The Podiatrist, Vol. 4, No 3, 1920, p. 6.