

# **FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?**

**FINAL DEGREE PROJECT**

**PODIATRY DEGREE**

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## INDEX

<b>1.</b>	<b>ABSTRACT / RESUM.....</b>	<b>pg. 4</b>
<b>2.</b>	<b>AIMS.....</b>	<b>pg. 5</b>
<b>3.</b>	<b>PERSONAL MOTIVATION.....</b>	<b>pg. 5</b>
<b>4.</b>	<b>MATERIALS AND METHODS.....</b>	<b>pg. 6</b>
<b>5.</b>	<b>INTRODUCTION.....</b>	<b>pg. 8</b>
5.1	LEGAL MEDICINE AND FORENSIC SCIENCES.....	pg. 8
5.2	FORENSIC PODIATRY.....	pg. 9
<b>6.</b>	<b>HISTORY.....</b>	<b>pg. 11</b>
6.1	HISTORY OF PODIATRY.....	pg. 11
6.1.1	History of Podiatry in Spain.....	pg. 11
6.2	HISTORY OF FORENSIC PODIATRY.....	pg. 12
6.3	FORENSIC PODIATRY NOWADAYS.....	pg. 13
6.4	FUTURE DEVELOPMENTS.....	pg. 14
<b>7.</b>	<b>THE ROLE OF THE FORENSIC PODIATRIST.....</b>	<b>pg. 15</b>
7.1	IDENTIFICATION PODIATRIST RECORDS.....	pg. 15
7.2	BARE FOOTPRINTS IDENTIFICATION.....	pg. 17
7.2.1	The Gunn Method.....	pg. 18
7.2.2	The Optical Centre Method.....	pg. 19
7.2.3	The Overlay Method.....	pg. 20
7.3	FOOTWEAR.....	pg. 23
7.4	FORENSIC GAIT ANALYSIS.....	pg. 27
7.5	WHAT IS NOT INCLUDED IN FORENSIC PODIATRY.....	pg. 30
<b>8.</b>	<b>FORENSIC PODIATRY IN CATALONIA, SPAIN.....</b>	<b>pg. 32</b>
<b>9.</b>	<b>DISCUSSION.....</b>	<b>pg. 33</b>
<b>10.</b>	<b>CONCLUSION.....</b>	<b>pg. 36</b>
<b>11.</b>	<b>BIBLIOGRAPHY.....</b>	<b>pg. 37</b>
<b>12.</b>	<b>ACKNOWLEDGMENTS.....</b>	<b>pg. 39</b>

**TABLE INDEX**

1. Table 4. Timeline of work progression of the final degree project.....pg. 7
2. Table 6.2 Brief Timeline with the History of Forensic Podiatry.....pg. 12
3. Table 7.1. Forensic Podiatry Tasks in Podiatry Treatment Records.....pg. 16
4. Table 7.2. Forensic Podiatry Tasks in Barefoot Prints.....pg. 22
5. Table 7.3 Forensic Podiatry Tasks in Footwear.....pg. 26
6. Table 7.4. Most common recognisable Gait Features and Gait forms in Forensic Gait Analysis.....pg. 28
7. Table 7.4.1 Forensic Podiatry Tasks in Gait Analysis.....pg. 30

**FIGURE INDEX**

1. Figure 5.2. Bone Structure of the foot.....pg. 10
2. Figure 6.1.1. The University of Barcelona was the first school of podiatry .....pg. 11
3. Figure 6.3. Logo of the American Society of Forensic Podiatry.....pg. 13
4. Figure 7.2. The Gunn Method.....pg. 18
5. Figure 7.2.1 Partial print analysis using The Gunn Method.....pg. 19
6. Figure 7.2.2. The Optical Centre Method.....pg. 20
7. Figure 7.2.3. The Overlay Method.....pg. 21
8. Figure 7.3. Focal Point Instrument.....pg. 24
9. Figure 7.3.1. Focal Points of Wear on the outsole of a shoe.....pg. 24
10. Figure 7.3.2. Preparation of footwear for internal examination.....pg. 25

## 1. ABSTRACT

Forensic podiatrists are specialised podiatrists in the field of Legal Medicine and Forensic Sciences. With their expertise level of the functioning foot, they are able to help the department of criminology. Their scope is divided in four subspecialties, in which each scope plays a very important part. Podiatry treatment records, barefoot prints, footwear and gait patterns are the main roles that forensic podiatrists employ. Forensic podiatry does not exist all over the world. It started in U.S.A and U.K. Currently in Catalonia, Spain, this field of podiatry still does not exist in 2015, but whether or not this will change in the future is questionable.

Key Words: Forensic Podiatry, Podiatrist, Footprints, Criminology and Forensics

## RESUM

Podòlegs forenses són podòlegs especialitzats en el camp de la Medicina Legal i Ciències Forenses. Amb el seu nivell de perícia dels peus en funcionament, són capaços d'ajudar al departament de criminologia. El seu àmbit d'aplicació es divideix en quatre sub-especialitats, en els quals cada àmbit té un paper molt important. Registres de podologia de tractament, gravats descalços, el calçat i els patrons de marxa són les funcions principals que podòlegs forenses fan servir. Podologia forense no existeix en tot el món. Es va iniciar en EUA i el Regne Unit. Actualment a Catalunya, Espanya, aquest camp de la podologia encara no existeix en 2015, però si això canviarà en el futur és qüestionable.

Paraules clau: Podologia Forense, podòleg, Petjades, Criminologia i Forense



## **2. AIMS**

The aims proposed in this study are to further understand this new field of podiatry and show how podiatrists are not limited just to work in a clinic or hospital but also for example in a crime scene.

These are the following aims.

- 1. To define how this new field came about.
- 2. To describe the role of the forensic podiatrist.
- 3. To propose the possibility of having forensic podiatry in Spain.

## **3. PERSONAL MOTIVATION**

I came across Forensic Podiatry as I was looking at International Podiatry Congresses and saw that this topic was spoken about.

Choosing a topic that hasn't been taught nor mentioned during our four-year Podiatry Degree at University, was an uncertain decision taken that soon after opened my learning horizons. I must add that I'm very thankful of my decision.

The idea of being able to develop various forensic podiatric concepts at once, and to learn how one becomes a forensic podiatrist was really important for me, as it is unknown in Spain.

In my opinion, Forensic Podiatry is quite an interesting topic that many podiatrists in Spain are unaware of. Perhaps one day; Spanish podiatrists may help, participate and solve crime cases along with the Forensic Department of the Spanish Police.

#### 4. MATERIALS AND METHODS

To achieve a proper finding, a bibliographic research was needed. The most used source of information was through online databases, as specific information about Forensic Podiatry was difficult to find.

Medical Science Articles was the source most employed to gather information about Forensic Podiatry and Forensic Podiatrists. Official and published articles were searched using the following databases: PUDMED and GOOGLE SCHOLAR. Words searched on these databases include, "Forensic" and "Podiatry" or "Podiatrist". Most articles were chosen in English, although some were also in Spanish. There was no minimum date of publication established, as that would have limited the resources for this project. Most articles and resources used are published as of 2010.

Books from the "*CRAI Biblioteca del Campus de Ciencias de la Salud de Bellvitge*" CRAI Library of Health Science Campus of Bellvitge of the University of Barcelona, were also used to further understand specific Biomechanical studies that Forensic Podiatrists use.

Apart from gathering bibliographic information, a personal meeting was held with Pablo Martinez a professional podiatrist, at the University of Barcelona,

Professionals in the Mossos d'Esquadra, Sargent Tomás Ramadán of the technical security planning division and Corporal Santiago Tugores of the scientific police division were contacted via email and interviewed about responsibilities and persons in charge.

Dr. Gabriel Martí, a professor of Legal Medicine of the University of Barcelona was interviewed and asked about Forensics. All the professional contacts were located in Spain. Contacting Forensic Podiatrists from countries in USA, UK and Canada has resulted difficult due to the lack of time.

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

Date	Facts/Duties/Actions
<b>October 2014</b>	Title of project requested including aims and tutors.
<b>November 2014</b>	Decision of title, tutor and modification of aims finalised.
<b>December 2014</b>	Bibliographic search of Forensic Podiatry.
<b>January 2015</b>	Personal meeting with podiatrist Pablo Martinez about his Thesis on podiatric dermatoglyphics related to criminalistics and forensic interest.
<b>February 2015</b>	Online conversation via email with Corporal Santiago Tugores of the Mossos d'Esquadra about barefoot prints and gait analysis.
<b>March 2015</b>	Personal meeting with Dr. Gabriel Martí, professor of legal medicine of the University of Barcelona.
<b>April 2015</b>	Advancement of project with information and interviews.
<b>May 2015</b>	Research with texts from the CRAI Library of the Health and Science Campus of Bellvitge.
<b>June 2015</b>	Final Degree Project handed in on the 8 <sup>th</sup> of June. Presentation on the 22 <sup>nd</sup> of June.

Table 4. Timeline of the final degree project work progression.

A timeline table (Table 4) was made for organisation of personal work.

## **5. INTRODUCTION**

### **5.1 LEGAL MEDICINE AND FORENSIC SCIENCES**

Legal Medicine defined by Gisbert Calabuig, is the combination of medical and biological knowledge necessary to resolve law problems.

Currently in Spain, expert Forensic Doctors assigned to the Legal Medicine Institutes are the ones mostly in charge of the Legal Medicine and Forensic Sciences. (Rapun, 2009).

Legal Medicine and Forensic Sciences in Spain consist of:

- Sanitary Rights
- Thanalogical Legal Medicine
- Forensic Pathology
- Sexology Legal Medicine
- Criminalistics, Forensic Identification and Genetics
- Forensic Psychopathology
- General Toxicology
- Social Toxicology
- Medication Risk and Pathology
- Industrial Medication Risk and Pathology
- Occupational Medicine

Legal medicine in Spain encompasses the following sub-disciplines:

- Forensic Anthropology
- Forensic Odontology
- Forensic Toxicology
- Forensic Psychology
- Forensic Genetics
- Forensic Biology
- Thanalogy
- Ballistics
- Medical Law

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

- Necropapilloscopy
- Legal Medicine of Somatic Diseases
- Forensic Psychiatric
- Forensic Photography
- Forensic Laboratory

In the U.S.A and the U.K, Forensic Podiatry is also part of the Legal Medicine and Forensic Science Institute. In the rest of the world, the Podiatrists seem to be excluded, in particular in Spain.

There are many different examples of Legal Medicine. The following could be the most related to Forensic Podiatry, if it were present in Spain.

- Sanitary Rights.  
Professional responsibility and malpractice claims
- Thanalogical Legal Medicine.  
Autopsy, Forensic Investigation
- Criminalistics, Identification and Forensic Genetic.  
Human Identification Protocol
- Forensic Psychopathology.

### **5.2 FORENSIC PODIATRY**

There are many professionals that are part of the Institute of Legal Medicine and Forensic Sciences. Many of which play an important role, one of those roles is the Forensic Podiatrist.

Evidence such as footprints and footwear are quite common to be found at a crime scene, thus it is important that it should be discovered, recorded and collected for further examination by the forensic podiatrist.

The foot is made up of a complicated structure (Figure 5.2.), which requires

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

years of experience to be able to distinguish all possible pathologies from: soft tissue, skeletal and biomechanical. Forensic podiatrists are trained for this knowledge.

This project has focused on the main scope of the Forensic Podiatrist, specifically on the identification and analysis.



Figure 5.2. Bone Structure of the foot. (Peña, D. Atlas de Dermatología del Pie)

## 6. HISTORY

### 6.1 HISTORY OF PODIATRY

Podiatry was formally founded in 1895 in the USA, with the first school of podiatry opening in 1911. In the UK, podiatry was established in 1912, where it then regained full professional recognition with a specialist knowledge based for many years.

#### 6.1.1 History of podiatry in Spain

In 1857, the first title of Chiropodist was established. After years of slowly becoming recognised, in 1952 the University of Barcelona officially taught the first course of “Diseases of the Foot”. The term “Podólogo” Podiatrist was applied at the end of 1950. (Peña, 2007)



Figure 6.1.1. The University of Barcelona was the first school of podiatry and first course of “Diseases of the foot”. (Novel Marti, V. 2009. Desarrollo de la Podología en España. University of Barcelona. Barcelona. Pg 115)

## 6.2 HISTORY OF FORENSIC PODIATRY

Forensic podiatry dates back to the 19<sup>th</sup> century. The first recordings or references (Table 6.2) demonstrate how slowly Chiropodists, then later on Podiatrists became Forensic Podiatrists.

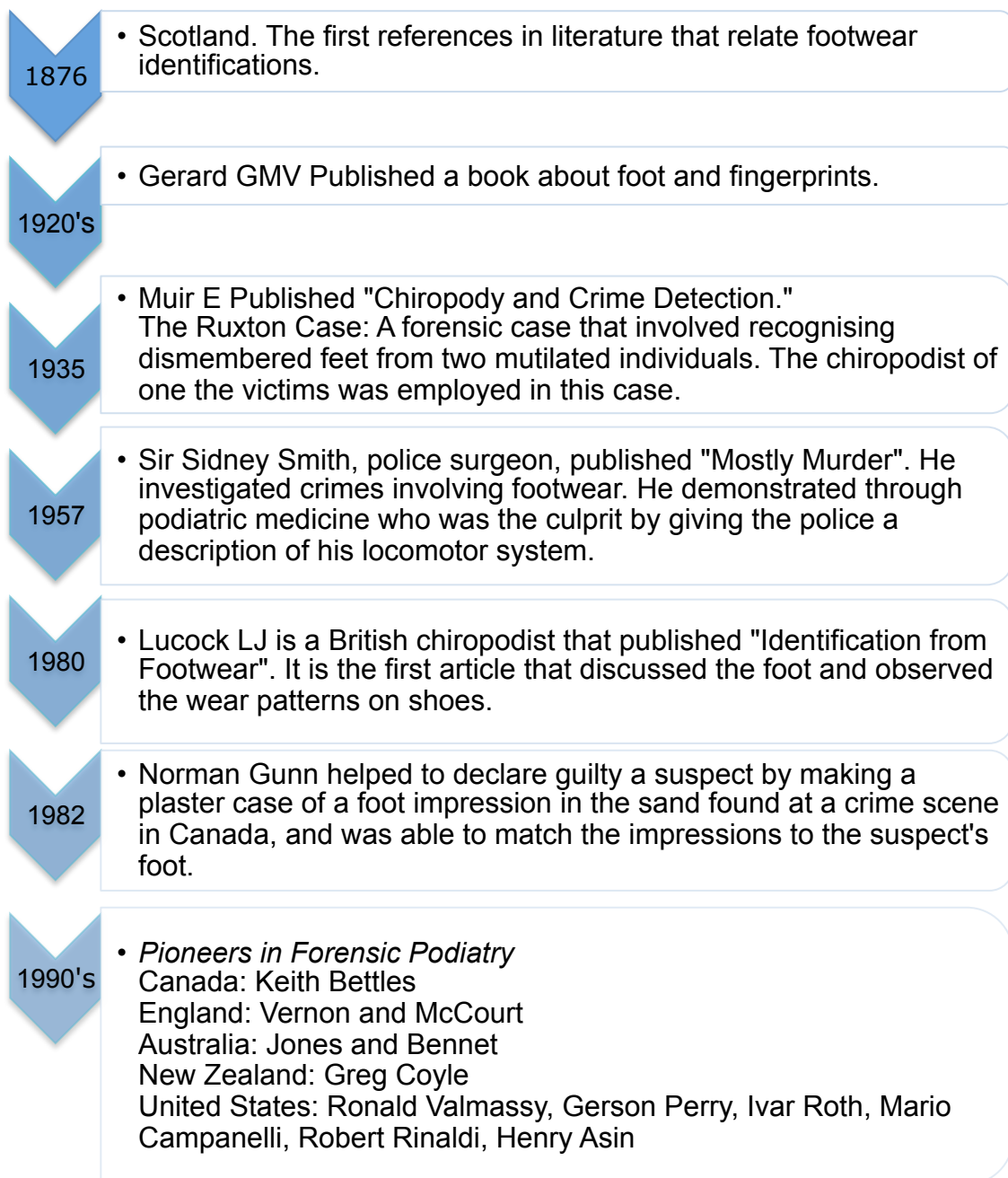


Table 6.2. Brief Timeline with the History of Forensic Podiatry. (DiMaggio, J.A. *The Role of Feet and Footwear in Medicolegal Investigations*. Forensic Medicine of the Lower Extremity: Human Identification and Trauma Analysis of the Thigh, Leg, and Foot. 2005.)



### 6.3 FORENSIC PODIATRY NOWADAYS AROUND THE WORLD

In today's society, American Podiatrists are active members of the American Academy of Forensic Sciences and Distinguished and Associate members of the International Association of Identification. Furthermore, American Podiatrists are also members of their forensic state societies and act as consultants to their local police departments.

Canadian podiatrists are also members of the Canadian Identification Society; British podiatrists are members of the British Association of Human Identification, Forensic Science Services, and the Centre for International Forensic Assistance.

The American Society of Forensic Podiatry (Figure 6.3) still quite new, promotes forensic sciences through continuing education for its members by means of educational seminars, research, publications, and through communication with other organized disciplines.



Figure 6.3. Logo of the American Society of Forensic Podiatry. Online. <http://www.theasfp.org/webfront/popup-misc.php?disclaimer=true>

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

Research plays a key importance for forensic sciences, so it is highly encouraged. Podiatrists are able to learn via virtual teaching, and these podiatrists will have a basic knowledge of footwear, and have the sufficient experience to understand foot morphology, pathological states and biomechanical imbalances.

Forensic podiatrists attend and participate in academic meetings and training seminars in the scientific community. Due to this, the podiatrist can comprehend law enforcement, criminal justice and laboratory techniques.

Postgraduate courses are currently in the process of forensic programs for podiatric medical students in the United States of America by The podiatric medical Educational System in the United States. (DiMaggio, 2005)

### **6.4 FUTURE DEVELOPMENTS**

The role and scope of practice of Forensic Podiatry will most likely evolve over time as techniques improve and research developments are implemented in practice. While it is impossible to state exactly what these changes will be. (Vernon, 2009) There are high hopes that Forensic Podiatry will gain its value in the rest of the world.

## **7. THE PRACTICE OF FORENSIC PODIATRISTS**

There are currently four main sub-specialties within the scope of practice of forensic podiatrists and these cover analysis and identification. (DiMaggio, 2007)

- I. Analysis and Identification involving Podiatry Treatment Records
- II. Barefoot prints
- III. Footwear
- IV. Gait Patterns

### **7.1. ANALYSIS AND IDENTIFICATION INVOLVING PODIATRY TREATMENT RECORDS**

Podiatrists keep a thorough record of all patients and all treatments carried out. This is very important specifically involving the identification of a person.

Records should contain the following information:

- Name
- Address
- Contact details
- Relevant medical history
- Record of the individuals foot type pathologies identified including the functional, structural and superficial pathologies affecting feet
- Treatment of the patient (Vernon, 2009)

The importance of the forensic podiatrist is to relate the individual's foot type, structural pathologies and the form, site, type and size of foot skin lesions.

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.

A project that studies the importance of analysis and identification that approximately 7.25% of the UK population would have a podiatry record. This suggests that there were sufficient numbers of the population with a record for the technique to be viable. Also, when podiatrist were asked to provide a simple identification judgment, the success rate was between 85% and 97% in relation to the proportion of correct judgments made. 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. (Vernon, 2006)

*Forensic Podiatrists tasks in Podiatry Treatment Records:*

- *To maintain the chain of custody at all times.*
- *Taking routine precautions in the handling of biological/hazardous waste*
- *Compliance with local mortuary procedures as required.*
- *Translation of clinical codings present on ante-mortem records.*
- *Assessment and recording of features listed in ante-mortem records.*
- *Assessment and recording of features of podiatric relevance present on the feet of an unidentified deceased person.*
- *Taking of X-ray and other diagnostic images of post mortem feet as required.*
- *Photography of features of post mortem feet as required.*
- *The management of digital images captured in the assessment process.*
- *Comparison of ante-mortem and post mortem data from above assessment process.*
- *Evaluation of the significance of matched and mismatched features apparent from the above comparison process with reference to established literature and/or database material as appropriate.*
- *Report compilation.*
- *Report verification by a peer podiatric examiner.*

Table 7.1. Forensic Podiatry Tasks in Podiatry Treatment Records. (Adapted from: Vernon, W. Forensic Podiatry: Role and Scope of Practice. 2009)

## **7.2 THE DESCRIPTION AND IDENTIFICATION OF BAREFOOT PRINTS.**

An individual's footprints can be used for identification, as they are just as unique as fingerprints. Though the key value in this part of identification is that a new footprint must be collected by a known person and compared to a questioned footprint.

It is important to know that even monozygotic twins have different footprints; so once being able to find the similarities it is a great step towards identifying possible people. Furthermore, standing footprints are smaller in size than walking footprints. (Singh, 2013)

In countries where it is common to walk barefoot, this identification process is used more frequently than in the Western World. Though some crimes of sexual nature (perpetrator has taken off his clothes) or a criminal has burnt his clothes and shoes, both leave behind bare footprints becoming very useful information.

As stated previously, a known and unknown footprint must be compared. Forensic podiatrist must collect as many possible suspect footprints to be able to compare them afterwards.

To collect a proper bare footprint, the suspect is required to walk uninterrupted along a 6-metre walkway. It is recommended that 2 podiatrists are controlling the situation, making sure there is a good quality footprints have been made. Recording this process is also very necessary.

A perfect and adequate footprint must include: 5 toes, ball of foot impression, heel impression, lateral mid-foot impression and arch profile. With all of these features, the size, the orientation and the shape help the identification.

Sometimes proper footprints are played with on purpose, or the culprit might not want to correctly step. On occasions, they will extend their toes so no toe is imprinted, contraction of the foot so the size is different and also some might

smudge the printing.

There are many techniques employed for barefoot identification, although there are three, which are predominating, which include: (DiMaggio, 2011)

1. The Gunn Method
2. The Optical Centre Method
3. The Overlay Method

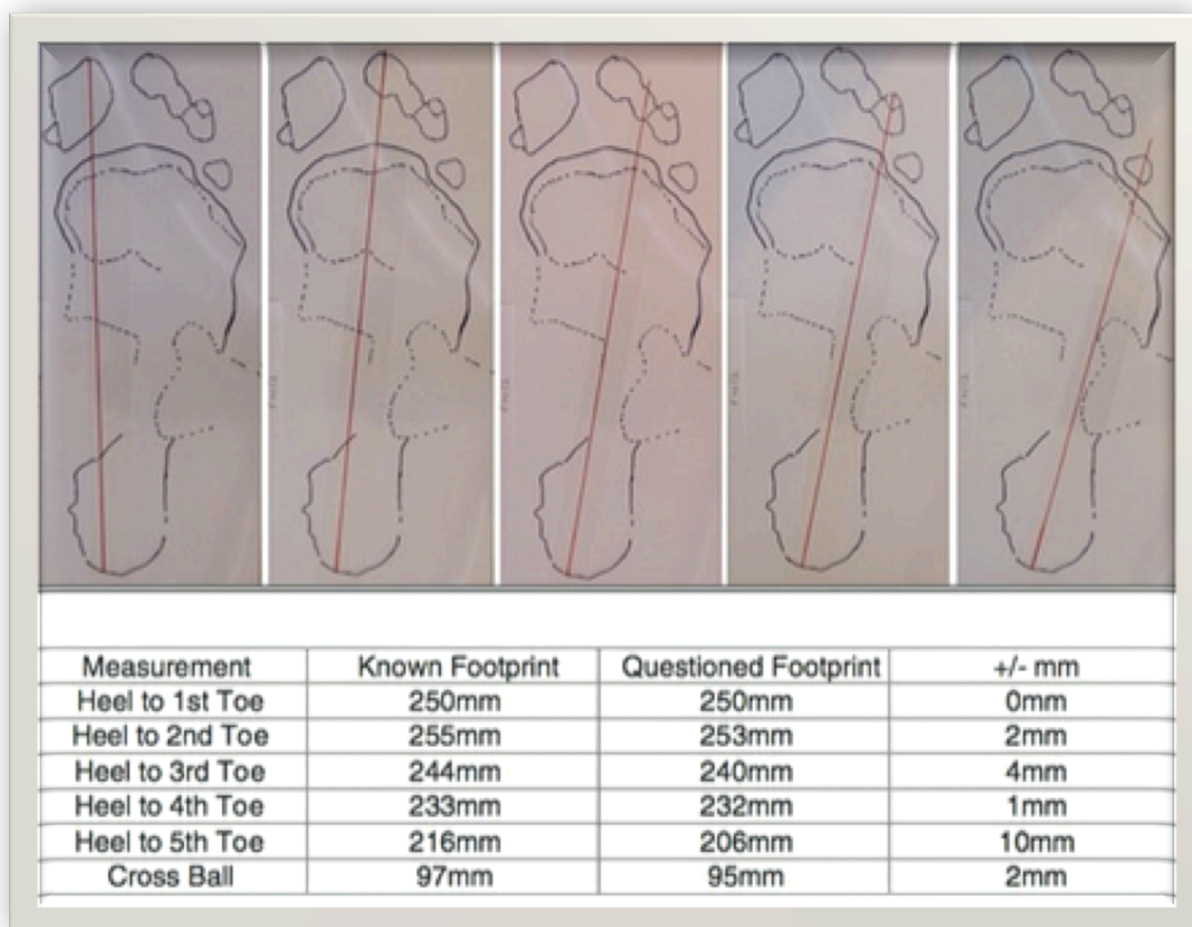


Figure 7.2. The Gunn Method. Lines are drawn from the most posterior area of the foot (heel), to each most anterior part of every toe. Then the lines are measured and compared. (Steven, G. Forensic Podiatry: A subspecialty for the 21st century?)

### 7.2.1. Gunn Method

The Gunn Method (Figure 7.2) uses a series of measured lines drawn to connect various identifiable landmarks of the foot. The main method is the 6-lined method. The first point is marked at the most posterior part of the foot

(heel) then points are marked at most distal part of each toe, then 5 lines are presented and measured. (Singh, 2013) There is also a different way to gather information for partial print analysis using The Gunn Method. The first point is located at the most medial area of the forefoot, then lines are connect to the most anterior part of each toe. Then the lines are measured and analysed (Figure 7.2.1.)



Figure 7.2.1. Partial print analysis using The Gunn Method. As there is no print of the hell, the most medial part of the ball of the foot is used, then the lines are measured. (DiMaggio, J.A. Vernon, W. *Forensic Podiatry:Principles and Methods.*)

### **7.2.2. The Optical Centre Method**

The Optical Centre Method (Figure 7.2.2.) is a variation of the Gunn Method. A circle is drawn exactly around a defined feature of the footprint. For example the toes are circled and also the heel. Then the centres of the circles are marked, and then lines are connected and drawn. (Singh, 2013)

Though a higher percentage of human error is present in this technique.

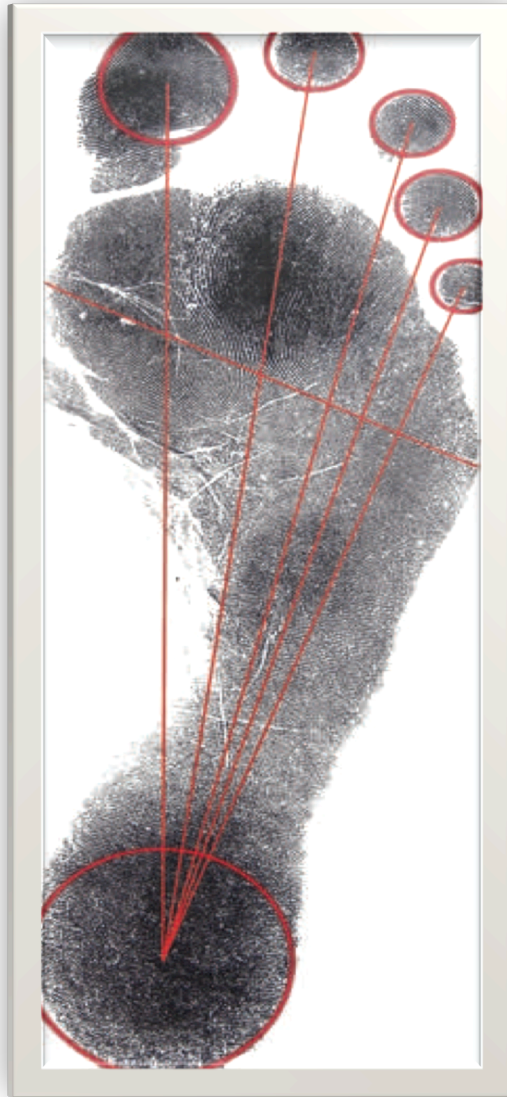


Figure 7.2.2. The Optical Centre Method. The centre of the circles are marked, and lines are connected. (DiMaggio, J.A. Vernon, W. *Forensic Podiatry: Principles and Methods.*)

### 7.2.3. The Overlay Method

In the Overlay Method (Figure 3), the perimeter is drawn of an identified footprint and then it is placed over an unknown footprint. A comparison of both is made and features such as the shape of the foot and of the toes, the leading edge of the ball of the foot are studied. Also, minor details such callouses and creases of lines are compared and matched. (Singh, 2013)





figure 7.2.3. The Overlay Method. The perimeter of the known footprint is drawn and compared to unknown footprint. (DiMaggio, J.A. Vernon, W. *Forensic Podiatry:Principles and Methods.*)

The value of podiatrists that bring into the process is in their complete understanding of the functioning foot and the effects, the foot type, the function of foot that may have on the form of the human footprint and identifications of foot pathologies such as retracted toes and hallux valgus. Also are able to consider and explain differences between compared footprints, where a footprint has been amended by function.

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

Although, further work is currently taking place to provide improved understanding of variable effects on footprints, which should enhance the value of footprints in identification.

### *Forensic Podiatrists tasks in Identification of Barefoot Prints:*

- *To maintain the chain of custody at all times.*
- *The capture of evidence quality digital images of footprints.*
- *Taking of X-ray and other diagnostic images of the feet of examined persons as required.*
- *Photography of features of the feet of associated persons as required.*
- *The digital management of footprint images in order to produce scale evidence quality images for analysis and comparison.*
- *The collection of exemplar footprints from a person suspected of being responsible for the formation of a questioned footprint, or who is to be eliminated from the enquiry.*
- *The observation of exemplar footprint collection in order to identify variable factors, which may affect repeatability.*
- *The examination and recognition of foot-related conditions of known persons.*
- *The description and comparison of the physical dimensions of footprint morphology.*
- *The comparison of dimensional and interpretive aspects of known and unknown footprints.*
- *The estimation of foot length and required shoe size from a footprint.*
- *The recognition of foot pathologies or specific characteristics of the foot from the footprint.*
- *The recognition of functional factors involved in the formation of a particular footprint.*
- *The evaluation of the significance of matched and mismatched dimensional and interpretive features apparent from the above comparison process with reference to established literature and/or database material as appropriate.*
- *The consideration and where apparent, the explanation of differences apparent between compared known and unknown footprints.*
- *Evaluation of the significance of matched and mismatched features apparent from the above comparison process with reference to established literature and/or database material as appropriate.*
- *Report compilation.*
- *Report verification by a peer podiatric examiner.*

Table 7.2. Forensic Podiatry Tasks in Barefoot Prints. (Adapted from: Vernon, W. Forensic Podiatry: Role and Scope of Practice. 2009)

### **7.3. ANALYSIS AND IDENTIFICATION INVOLVING FOOTWEAR**

The relation of criminal identification via footwear has been around for many years. These frequently include the finding of shoeprints at the scene of crime, which could then potentially be linked to the outsole of the shoe that made these prints. Where the shoeprint is available at the crime scene, the task is to match that print to a shoe later found or seized from a suspect. Many aspects of footwear identification are also included in 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.

The task of linking an individual to a pair of shoes is centred on the foot impression within the shoe, with the techniques used in barefoot impression comparisons like Gunn, Optical Centre and Overlay Methods. 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. (DiMaggio, 2011)

There are three different ways to obtain information from shoes.

- Outer impressions
- Inner impressions
- Other evidence from shoes. (Singh, 2013)

The examiner should initially observe the footwear item from all angles. Detail of the style, indicated make (if known), shoe type, colour, and marked size should be recorded as well as a subjective assessment of the general condition of the shoe. Descriptors of any wear, distortions, and crease lines of the upper should be made in the examiner's notes, as should the presence of any unusual features such as areas of deliberate damage and style of lacing. The outsole is then examined for signs of wear and where such wear is present, this should be recorded.

The focal point "instrument" (Figure 7.3) is a tool that considers the areas of the outsole from which each anatomically referenced component of wear spread. The focal point instrument is not a tool as such, but a means by which the

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

examiner can describe the outsole wear for later comparison purposes. Areas 1 to 9 are located in the heel and areas 10 to 21 are located in midfoot and forefoot. (DiMaggio, 2011)

Figure 7.3. Focal Point Instrument is used to consider the wear areas on outsides of shoes. (DiMaggio, J.A. Vernon, W. *Forensic Podiatry: Principles and Methods*)

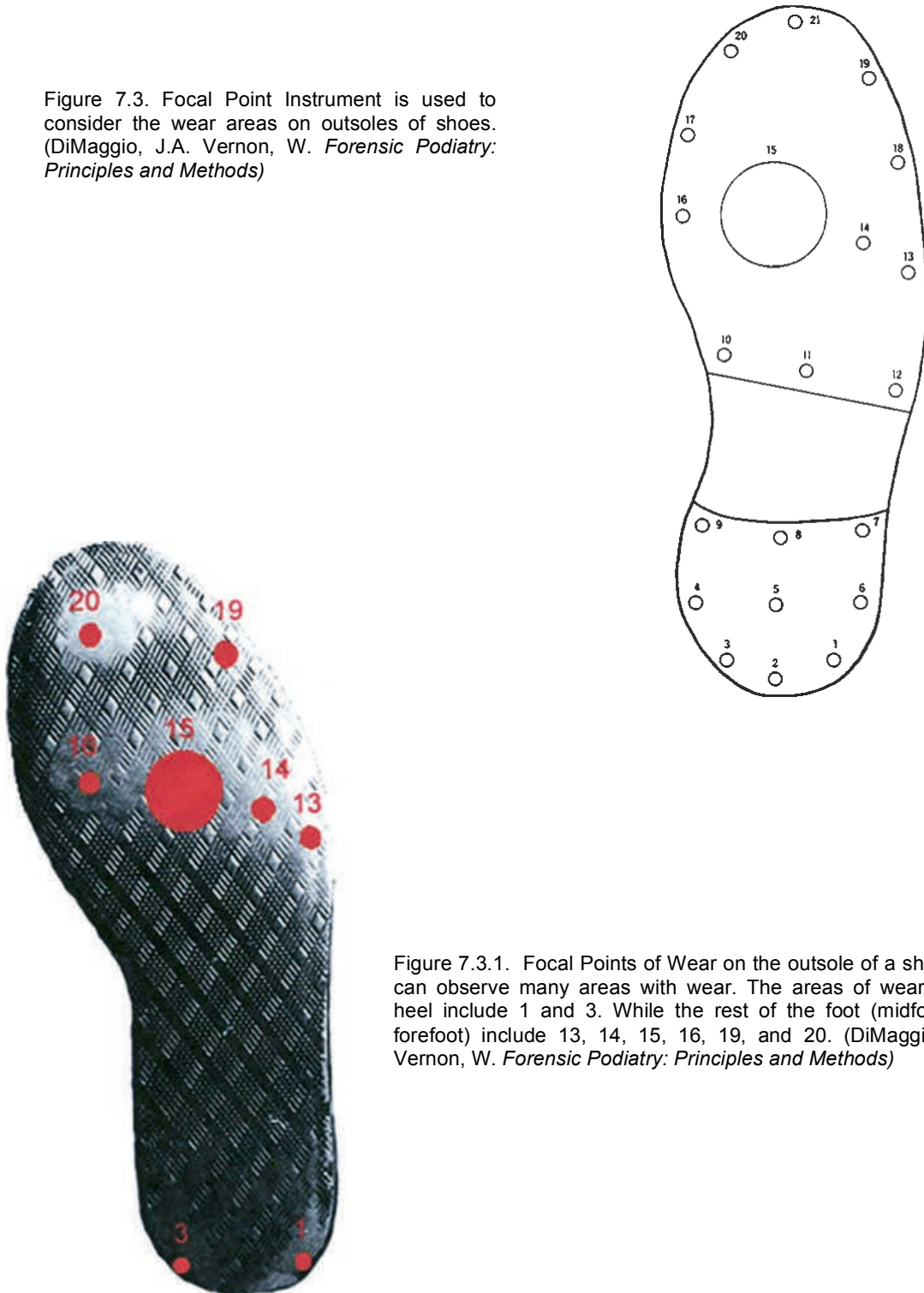


Figure 7.3.1. Focal Points of Wear on the outsole of a shoe. We can observe many areas with wear. The areas of wear of the heel include 1 and 3. While the rest of the foot (midfoot and forefoot) include 13, 14, 15, 16, 19, and 20. (DiMaggio, J.A. Vernon, W. *Forensic Podiatry: Principles and Methods*)

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

Inner impressions are imprints that have been left in the inside of shoe by contact from the person's foot. (Figure 7.3.2.)

Analysis of the insole impressions can be used to link a person to a piece of footwear.

Other evidence from shoes is when body hair, body fluids, skin tags, dust particles, glass fragments can be found on shoes. The study of this trace evidence could be used to link the footwear to a location or owner. (Singh, 2013)



Figure 7.3.2. Preparation of footwear for internal examination. (DiMaggio, J.A. Vernon, W. *Forensic Podiatry: Principles and Methods*)

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

### Forensic Podiatrists tasks in Analysis and Identification involving Footwear:

- *To maintain the chain of custody at all times.*
- *Initial risk assessment of footwear to determine the appropriate precautions to be taken during the examination.*
- *The adoption of safe governance approaches as determined through the above.*
- *The initial digital image capture of footwear under consideration.*
- *Preliminary assessment of footwear to ascertain benefits of proceeding with the examination.*
- *The opening of footwear to investigate and display internal wear features.*
- *The capture of evidence quality digital images of the foot impression apparent on the insole/sock liner of the shoe.*
- *The digital management of footwear images in order to produce scale evidence quality images for analysis and comparison.*
- *Taking of X-ray and other diagnostic images of the feet of examined persons as required.*
- *Photography of features of the feet of associated persons as required*
- *The collection of exemplar footprints (if deemed necessary) from a person suspected of having worn a questioned footwear item, or who is to be eliminated from the enquiry.*
- *The observation of exemplar footprint collection in order to appreciate variable factors, which may affect repeatability.*
- *The verification of internal size dimensions of the shoe.*
- *The examination and recognition of foot-related conditions and dimensional aspects of the feet of known persons who may have worn the shoes.*
- *The recognition and description of wear features of the inner, upper and outsole aspects of the shoes.*
- *The comparison of the physical dimensions of known and unknown feet and footwear examined.*
- *The comparison of wear features present within/on known and unknown feet and footwear examined.*
- *The comparison of foot impression dimensions and features between known and unknown shoes.*
- *Comparison of known and questioned footprint data from the above assessment process.*
- *The estimation of foot length and required shoe size from a footprint.*
- *The recognition of foot pathologies or specific characteristics of the foot from the wear features of the examined shoes.*
- *The recognition of functional factors involved in the formation of a particular wear features of the examined shoes.*
- *The evaluation of the fitting match between feet and shoes in known and unknown footwear examined.*
- *The evaluation of the significance of matched and mismatched dimensional and interpretive features apparent from the above comparison process with reference to established literature and/or database material as appropriate.*
- *The consideration and where apparent, the explanation of differences apparent between compared known and unknown footwear items and feet examined.*
- *Report compilation.*
- *Report verification by a peer podiatric examiner.*

Table 7.3. Forensic Podiatry Tasks in Footwear. (Adapted from: Vernon, W. Forensic Podiatry: Role and Scope of Practice. 2009)

#### **7.4. FORENSIC GAIT ANALYSIS**

Forensic gait analysis is the recognition or identification of a person or people by their gait or gait traits. It is a new technique, which will soon become a very valuable tool in identification.

Kelly (2000) and Grant (2006) have both described what forensic gait analysis is. At the same time both definitions use identifications via persons gaits or gait traits, but at the same time, Kelly (2000) describes that normally closed circuit television footage is used, and Grant (2006) describes that it is possible to identify a person by their unique characteristic manner of walk. (DiMaggio, 2011)

The gait can be divided into two sections; The Stance Phase (foot is in contact with the ground) and The Swing Phase (foot is not in contact with the ground).

Gait analysis is the interpretation and quantification of human movements including: foot and ankle, knee and hip.

There are two ways to evaluate:

1. Qualitative

The use of non-numerical data used for the evaluation of movement. A visual assessment is needed with sagittal, frontal and rear views.

2. Quantitative

The analysis of numerical information collected. Forces, pressure and movements are calculated. Technology is needed in this case. (DiMaggio, 2011)

The first forensic gait analysis was first documented in July 2000. The identification of a jewellery thief was identified using forensic gait analysis. He was recognised by his bow-legged style of gait (*genu varum*). A study conducted by Buncombe (2000) and Miles (2001) has estimated that 5% of the population present a bow-legged style of gait. (DiMaggio, 2011)

There are gait forms and gait features (Table 7.4) that are used in forensic gait analysis to identify a person.



FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

Recognisable Characteristic	Gait Related Pattern	Description
<b>Abduction (Out-toed gait)</b>	Gait Feature	Increased outward rotation of the extremity while walking. (Perry, 2010)
<b>Adduction (In-toed gait)</b>	Gait Feature	Increased inward rotation of the extremity while walking. (Perry, 2010)
<b>Ankle Equinus</b>	Gait Feature	A toe-down position of the foot in which the forefoot is lower than the rearfoot. (Perry, 2010)
<b>Ataxic Gait</b>	Gait Form	Unsteadiness, irregularity and wide base gait. (Stolze, 2002)
<b>Calcaneal Gait</b>	Gait Form	Primarily walking of the heels. (Perry, 2010)
<b>Chorea Gait</b>	Gait Form	Wide-based gait with slow leg raising and simultaneous knee flexion. (Willacy, 2014)
<b>Drop foot</b>	Gait Feature	Passive equinus and excessive ankle plantar flexion during the swing phase. (Perry, 2010)
<b>Excessive Ankle Dorsiflexion</b>	Gait Feature	Dorsiflexion that exceeds the normal in all phases of the gait cycle. (Perry, 2010)
<b>Genu Valgum</b>	Gait Feature	The distance between both feet is greater than the distance between both knees. (Kirby, 2002)
<b>Genu Varum</b>	Gait Feature	The distance between both knees is greater than the distance between both feet. (Kirby, 2002)



## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

<b>Hemiplegic Gait</b>	Gait Form	Spasticity and primitive patterns of motion. (Perry, 2010)
<b>Limping</b>	Gait Form	Gait abnormality with some degree of asymmetry. (Whittle, 2012)
<b>Scissor Gait</b>	Gait Form	Legs, knees and hip flexed appearing to be crouching. Knees and thighs hit each other with a scissor move. (Willacy, 2014)
<b>Shuffling Gait</b>	Gait Form	Irregular stepping. (Alwan, 2003)
<b>Toe Walking</b>	Gait Form	Walking on the ball of the foot and on toes. There is no contact of the heel. (Whittle, 2012)
<b>Waddling Gait</b>	Gait Form	Trunk sways from one side to another while walking. (Whittle, 2012)

Table 7.4. Most common recognisable Gait Features and Gait forms in Forensic Gait Analysis

In forensic gait analysis, the podiatrist would examine recordings of events which have been captured on closed circuit television 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.

### Forensic Podiatrists tasks in Forensic Gait Analysis:

- *To maintain the chain of custody at all times.*
- *Selection of suitable equipment in order that a detailed analysis of the footage can be performed.*
- *When relevant, instructing police agencies/lawyers in the forensic gait analysis requirements for the collection of any additional footage from known persons suspected of being present in the questioned footage, or who is/are to be eliminated from the enquiry.*
- *Preliminary assessment of footage under consideration, to determine whether the material is of sufficient quality to proceed and whether any meaningful analysis of the material is possible in a forensic context.*
- *Performing an in-depth assessment of the footage with observational recordings being made, to include appropriate qualitative and quantitative analysis.*
- *Comparison of the footage of unknown and known persons.*
- *Evaluation of the significance and use of scale/s of support for matched and unmatched features apparent from the above comparison process, with reference to established literature, clinical data, or database material as appropriate.*
- *The consideration and where apparent, the explanation of differences observable between the compared unknown and known footage.*
- *Where necessary, observational population data collection for comparative purposes.*
- *Report compilation.*
- *Report verification by a peer forensic examiner.*

Table 7.4.1. Forensic Podiatry Tasks in Gait Analysis. (Adapted from: Vernon, W. Forensic Podiatry: Role and Scope of Practice. 2009)

### **7.5 WHAT IS NOT INCLUDED IN FORENSIC PODIATRY.**

It is important to understand what isn't included in forensic podiatry as it is a practice that is closely related to other forensic disciplines.

#### **Recovery of evidence from crime scenes**

Forensic Podiatrist can recover evidence from a crime scene, but this process requires extensive training in forensic skills and normally Scene of Crime Officers, in the United Kingdom and Crime Scene Investigators in the United States of America, are in charged of this.

Forensic Podiatrists can discover and recover information but must be undertaken without putting in hazard other evidence types. Specialist advice could however be requested from a forensic podiatrist by such crime scene

specialists to help them in their work. (Vernon, 2009)

### **Bare footprints**

Finger print examiners should always be referred to when ridge detail is present in a bare footprint. Forensic podiatrist cannot link a suspect with a bare footprint, as it is not in their scope of practice. Though any podiatrist may go through specific training wishing to undertake such work. (Vernon, 2009)

### **Forensic Gait Analysis**

A forensic podiatrist cannot refer to specific clothing characteristics nor visual height estimations, as this would not be included in the forensic podiatrist's expertise. Comments of gait and/or gait features of a person and an understanding of the affects of a person's gait is necessary and may be discussed during oral evidence in court. (Vernon, 2009)

## **8. FORENSIC PODIATRY IN CATALONIA, SPAIN.**

This project will be focalised on the autonomous community of Catalonia. Where the Mossos d'Esquadra in 2008 completely replaced Spain's National Police and Guardia Civil within the territory of Catalonia. As of 2005 The Mossos d'Esquadra took full duty in Barcelona. This is important to mention as the only communities to have a different police identity in Spain are Catalonia and Basque Country.

Forensic Podiatry does not exist in Spain and also, it does not exist in Catalonia.

The department of the "Centre de Identificació" Identification Centre of the Division of Forensic Science in Catalonia are responsible with the analysis, recognition and evaluation of barefoot prints and shoeprints.

Gait Analysis is hardly used, as it is difficult to know the subject's gait, especially when the subject is unknown. The Body of the Mossos d'Esquadra are in charged of this section.

Dr. Pablo Martinez is a young professional podiatrist helping the department of criminology of the Mossos d'Esquadra. Helping them to understand barefoot prints. Pablo completed his Master of Podiatric Surgery completing his final work on podiatric dermatoglyphics related to criminalistics and forensic interest.

His knowledge and interest in this topic motivates him to believe that Forensic podiatry in Catalonia will soon become like in those existing countries. A postgraduate course or master's course on Forensic Podiatry will be the first tiny step into this long goal achievement.

## 9. DISCUSSION

Forensic Podiatry is a new type of field in the world of Legal Medicine and Forensic Sciences. Leading podiatry countries (U.S.A and U.K) are the only ones that have officially introduced it.

To complete this project, it has been difficult to find resources. No valid information was found about forensic podiatry in Spain. Thus, most of the resources used had to come from the U.S.A and U.K.

The aims were established simply to understand what is forensic podiatry and forensic podiatrist and what does a forensic podiatrist do. As previously said, as there are no forensic podiatrists in Spain and this has limited the search in Spain. The last aim is to propose a way that forensic podiatry could be added to Legal Medicine and Forensic Sciences.

Materials and Methods have been divided into two major parts. The first half consists of gathering as much information to be able to learn, relate and understand forensic podiatry. There's no abundance of resources even in countries already existing forensic podiatry. The second part consists of interviews with different professionals from legal medicine and bodies of police. Without these interviews, it would have been extremely difficult to propose a future of forensic podiatry.

To understand forensic podiatry, first it is necessary to learn about legal medicine and forensic sciences. Knowing that legal medicine involves medicine and law, and that there are many sub-disciplines, like forensic odontology and forensic psychology in Spain. Podiatry in Spain is one of the most important and leading in Europe and the world. Spanish podiatrists would be just as expertise and North American and English podiatrists in forensic podiatry.

This history of podiatry is very important to analyse, as we can see that first podiatric school in Spain was founded not much later than in U.S.A or U.K. This goes to show that Spanish podiatrist are at the same level as in U.S.A or U.K. There are many schools of podiatry around the world that are members of types of Forensic Sciences.

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

The practice of forensic podiatrists must vary in those already existing countries. It is important to know what can or what is the forensic podiatrist in charge of and what they are not in charge of. After learning about the scopes of practice, there is definitely the sufficient amount of basic formation in the universities of Spain related to podiatry. Spanish podiatrists are expertise in the structure and function of the foot, which is a very complex structure, and it requires the podiatrist deep knowledge in various fields. Also, Spanish podiatrists constantly work analysing gait cycles and gait features, footwear therapy and also 2-dimensional image capture of inked footprints, and this practice is majorly what a forensic podiatrist does. Making Spanish podiatrists completely viable with legal medicine and forensic sciences.

After four years of studying podiatry at the University of Barcelona, I have come to understand that this profession is not just about day-to-day clinical exploration and treatment, but there is much more to investigate and to grow within the practice. The joining of podiatry to the legal medicine and forensic sciences would be just as great for both podiatrists and forensic science practitioners. Catalanian and Spanish forensic departments could learn much more with a podiatrist on their team.

It is a difficult yet not impossible situation to propose forensic podiatry in Spain. I believe that not only are the legal medicine and forensic science practitioners unaware of forensic podiatry, but also many podiatrists are completely unfamiliar with this field too.

It would be a tremendous opportunity for Spanish podiatrists to be able to attend forensic podiatry presentations in national and regional podiatry congresses. This would help spread the existence of forensic podiatry in Spain.

In relation to podiatry students, learning about legal medicine and forensic sciences while at university would be a significant forward step into forensic podiatry.

To propose forensic podiatry in Spain and/or Catalonia, there would be a few necessary criteria.

## FORENSIC PODIATRY: A NEW PATH FOR PODIATRISTS?

In order for forensic podiatry to become official in Catalonia or Spain, there should be compulsory processes required to practice competently in legal medicine.

Firstly, only qualified podiatrists can practice forensically. There needs to be an official additional formation. It would be a great idea to follow the steps of already practicing countries like the U.S.A and U.K, where there is more than one way of becoming a forensic podiatrist as Wesley Vernon has mentioned in 2009. These include:

- Masters Degree
- Forensic Science Degree Programs
- Post Graduate Diploma Programs
- Expert Witness Training Programs
- Forensic Podiatry Workshops
- Research Activity in Forensic Podiatry

This is very similar to other forensic practitioner trainings and could easily be adopted in Catalonia and Spain. I completely agree with Vernon as he mentions that it is unconceivable that this last phase could be completed in less than 12 months. It takes time to become a forensic podiatrist, as one should reach expertise level. That is why it would be a great idea to have a regular mentorship from a competent forensic practitioner.

Legal medicine practitioners, have seem to be quite interesting about forensic podiatry and having a forensic podiatrist part of the team.

During 2015-2017, the IV Masters Degree in Forensic Sciences will take place at the University of Barcelona, and graduate podiatrists are invited to enrol.

Whether or not forensic podiatry will or will not become official in Catalonia or Spain, it is still important to know that there are lots of different paths in podiatry.

## 10. CONCLUSION

Forensic podiatry has existed for many years but has received the recognition it has today not long ago.

Forensic podiatrists are professionals specialised in feet that have expertise level related to the foot. To become a forensic podiatrist one must firstly become a podiatrist, then each country has it's own laws on how to become a forensic podiatrist.

There are four subspecialty roles that a forensic podiatrist is in charge of. A forensic podiatrist can help cover and analyse the identification process with podiatric treatment records, the use of barefoot prints, the understanding of footwear prints and footwear internally and externally.

There are no forensic podiatrists in Spain or Catalonia. Spanish podiatrists are more than capable after 4 years of study. Spanish podiatrists should collaborate with forensic legal medicine and forensic sciences department of the National Police or with Regional Police when necessary because they have a key knowledge of the functioning foot as it is in other countries like USA and UK.

A proposal for forensic podiatry in Catalonia and/or Spain has been established where:

- There should be a postgraduate or masters degree for qualified podiatrists on forensic podiatry.
- National and regional Spanish podiatry congresses should present forensic podiatry for podiatrist to become aware of this field.
- While studying podiatry at university, there should be subjects related to legal medicine and forensic sciences.

This would help to conscience and aware what is forensic podiatry to current and future Spanish podiatrists.



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