

A Path of Sympathetic to Forensic Science from the Sight of Forensic Anthropology

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Abstract

Over the past few decades the field of forensic science has experienced a remarkable development and sustainability enhance the public profile. Due to increasing the different techniques to do the crime, there must be some unique and diverse methods to investigate it. The prominence of forensic science has concluded from scientific and technological advancement, increase in reliance of law enforcement and judicial system. Some of the crimes are smartly occurred, that in investigation there are no clues and evidence would be found to excess the further investigation. Anthropology is a unique and old way to easily notice the clues at crime scene. With the help of forensic anthropology, anthropologist can distinguish the possible stories behind the crime. Even in psychological way, the method can also sense the psychology of the criminal. This review paper aims to identify how best to organize and deliver forensic science education. It also explains the relation the important part of the anthropology in forensic science and how forensic anthropology can be useful at crime scenes. This paper also endeavours that how forensic anthropology can easily detect the clue physically and psychologically to investigate the crime scenes with the help of some hypothesis cases.

Keywords: Forensic science • Forensic anthropology • Crime Scene Investigation (CSI) • Anthropology in bones

Introduction

The word "Forensic" originates from the Latin word "forensis", which means public, to the forum and public discussion. Any science used for the purposes of the law is a forensic science. Forensic Science deals with the various applications of scientific knowledge to legal problems and they are vital tools for the unearthing the truth in any legal proceedings. Forensic science includes various subjects like forensic chemistry, forensic biology, forensic anthropology, forensic medicines, forensic material sciences, forensic engineering, computational forensic and so on, are broadly used to resolve the civil disputes to justly enforce criminal laws and government regulations and to protect public health [1-3]. Forensic science refers to the application of natural, physical and social sciences to matters the law. Most of the forensic scientists hold that investigation begins at the scene. The proper investigation, collection and preservation of evidence are essential for fact-finding and for ensuring proper evaluation and interpretation of the evidence, whether the evidence is bloodstains, human remains, hard drives, ledgers, and files or medical records. Scene investigations are concerned with the documentation, preservation and evaluation of a location in which a criminal act may have occurred and any associated evidence within the location for the purpose of reconstructing events using the scientific method. The proper documentation of a scene and the subsequent collection, packaging and storage of evidence are paramount. Evidence must be collected in such a manner to maintain its integrity and prevent loss, contamination, or deleterious change. Maintenance of the chain of custody of the evidence from the scene to the laboratory or a storage facility is critical. A chain of custody refers to the process whereby investigators preserve evidence throughout the life of a case. It includes information about:

who collected the evidence, the manner in which the evidence was collected and all individuals who took possession of the evidence after its collection and the date and time which such possession took place [4-7].

Literature Review

If "forensic science" refers to science applied to criminal and civil law, one may wonder which of the sciences actually forensic sciences are. The answer may surprise you. Any science can be a forensic science if it has some application to justice. Think about how many different areas of science could potentially be brought to bear on solving crimes. Many medical, physical, and biological sciences have forensic applications, as do math, business practices, sociology and psychology. Forensic science is a very broad field as any science or piece of knowledge used to assist in resolving a legal issue or case can enjoy the adjective 'forensic' in such context [8,9]. Forensic science employs physical, biological, medical and even behavioural sciences to examine, analyse and evaluate physical evidence, human beings and even traces evidence to matters pertaining to law. Unlike what some may perceive, forensic science is not restricted to criminal law matters and criminal cases. Its landscape expands to cover civil laws and cases [10-13]. Because forensic science is a broad field, it is nearly impossible to conceive such a field of study that comprises all these underpinning disciplines, applications and specialisations. Therefore, this research will focus on a working definition of forensic science that is confined to the application of physical sciences, biological sciences and other uniquely forensic forms of inquiry and techniques to matters relating to both criminal and civil law. In other words, the working definition of forensic science will be limited to criminalistics. Hence, it will exclude many other areas related to the forensic science field such as forensic pathology, anthropology, odontology, entomology, psychiatry, computing, accounting, etc. The confining of the working definition will simplify the conduct of this research. However, it cannot ignore the epistemological complexity of forensic science which will be a challenge for any university forensic science course [14-16].

History of Forensic Science

The roots of Forensic Science can be traced back to ancient Greek and Roman civilizations which brought great advances in the field of

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Received: 30 March, 2021 Accepted: 12 April, 2021 Published: 19 April, 2021

various disciplines of science including the science associated with criminal investigation. Poisoning being one of the earliest methods of killing a human being, widespread knowledge was gathered regarding its production and use. Symptoms caused by various poisons were identified making it possible to detect their use in previously undetected murders. The first recorded autopsy was also conducted by a Roman physician Antistius in 44 B.C. on the body of a slain king Julius Caesar to reach the conclusion that though the king was stabbed 23 times, only one wound through his chest caused his death. In the beginning of the seventeenth century, also known as the age of enlightenment, advancements in sciences and awakening of the social conscience resulted in revitalized interest in the field of forensic science. This inquisitiveness necessitated new means to identify evidences for the purpose of solving crimes. Further, in the eighteenth and nineteenth centuries, a large number of incidents of collection and scientific analysis of evidences in order to solve crimes and convict the culprits were recorded. Evidentiary techniques included identifying foot prints, matching a piece of crumbled newspaper used for wadding in a pistol to a torn piece of paper in a suspect's pocket, matching clothing fibers and grains etc. collected from a crime scene to those found on a suspect of a murder. In the 19th century, it was observed that contact between someone's hands and a surface left barely visible marks called fingerprints. Fine Powder Dusting technique was used to make the marks more visible [17-19].

Modern fingerprint identification technique dates back to 1880 when a British scientific journal Nature published a letter from the Englishmen Henry Faulds and William James Herschel disclosing the characteristics of uniqueness and permanence of fingerprints. Their observations were verified by the English scientist Sir Francis Galton, who introduced the first elementary system for classifying fingerprints based on grouping the patterns into arches, loops, and whorls. Galton's system was improved upon by London police commissioner, Sir Edward R. Henry. Known as Galton-Henry system of fingerprint classification, it was published in June 1900 and officially introduced at Scotland Yard in 1901. It is the most widely used system of classification even today. Surprisingly, while the use of scientific methods and techniques in criminal investigations in some manner or another has been around since before the Roman Empire, the idea of forensic science as a discipline and a career is hardly 100 years old. It has only been within the last century that law enforcement agencies and the court systems have come to rely so heavily on the use of scientific practices in crime scene investigations. Throughout history, there exist examples of analysis of various pieces of evidence leading to convictions or acquittals that seem to fall in line with what we know and recognize as Forensics [20,21].

Different Branches of Forensic Science

Criminalistics: A scene reconstruction is the process of putting the pieces of an investigation together with the objective of reaching an understanding of a sequence of past events based on the physical evidence that has resulted from the event. The scientific method approach is the basis for crime scene reconstructions, which includes a cycle of observation, conjecture, hypothesis, testing, and theory. The process of recognizing, identifying, individualizing, and evaluating physical evidence using forensic science methods to aid in reconstructions is known as criminalistics [22]. Here, identification refers to a classification scheme in which items are assigned to categories containing similar features and given names. Objects are identified by comparing their class characteristics with those of known standards or previously established criteria. Individualization is the demonstration that a particular sample is unique, even among members of the same class. Objects are individualized by their individual characteristics that are unique to that particular sample. Other important concepts in criminalistics include the comparison of objects to establish common origin using either a direct physical fit method or by measuring a number of physical, optical and chemical properties using chemistry, microscopy, spectroscopy, chromatography as well as a variety of other analytical methods [23-25].

Pathology: When some people think of forensic science, they envision dead bodies and autopsies. Not all of forensic science is like this, but forensic pathology is. The forensic pathologist is a medical doctor who first specialized in pathology and then in forensic pathology. Forensic pathologists determine

the cause and manner of death in cases where someone dies under suspicious or other circumstances as prescribed by state law. Many forensic pathologists work for state or local medical examiners or coroners. These are appointed or elected officials who must decide when a medicolegal autopsy is needed and they must sign death certificates that indicate the cause and manner of death. Medical examiners and coroners don't usually perform the autopsies themselves [26,27].

Anthropology: Forensic anthropologists work with skeletal remains. They identify bones as being human or animal. If animal, they determine the species. If human, they determine from what part of the body the bone originated. If they have the right bones, gender can be determined as well. Sometimes age can be approximated and racial characteristics determined, and even socioeconomic status may be estimated. If there is an injury to skeleton or major bones, the anthropologist can help determine the cause of the injury or even death. Forensic anthropologists do other things besides identifying bones. They also work closely with skulls. It is possible to literally build a face onto a skull, using clay and wooden or plastic pegs of various sizes. Using charts that give average tissue depth figures for various parts of a face, an anthropologist constructs a face and then makes judgments as to that person's eye, nose and mouth characteristics. Facial reconstruction can be useful in helping to identify a missing person from the face built around a recovered skull. It is also possible for a forensic anthropologist to superimpose a skull onto a picture of a face to see if they are one and the same person [28].

Odontology: "Odontology" is a synonym for dentistry. You may be curious about how a dentist could be a forensic scientist, but actually there are several ways. A few years ago in Pennsylvania, a burglar broke into a house and ransacked it for valuables while the owners were on vacation. During his foray, he got hungry and rooted through the refrigerator for something to eat. He found a hunk of Swiss cheese and took a bite. Later, he was arrested, trying to "fence" (sell on the black market) the stolen merchandise. When the police investigated the home looking for clues that would tie him to the scene, they found the cheese. A forensic dentist made a cast of the bite mark in the cheese and matched it to an impression of the burglar's teeth [29].

Toxicology: Toxicology is an interdisciplinary science dealing with the study of adverse effects caused by xenobiotics on living organisms, notably study of intoxication or behavioural symptoms, action mechanisms aka pharmacodynamics or toxicodynamics, disposition aka pharmacokinetics or toxicokinetics and bioanalysis, risk assessment and specific treatment of intoxicated patients. Xenobiotics are chemicals that are foreign to living systems and usually harmful, either toxins as biochemicals produced by living systems such as plants or animals or toxicants. Pharmacokinetics and toxicokinetics deal with the absorption, distribution, metabolism of xenobiotics on their way to target sites, and excretion from human body. Disposition depends upon the current biochemical status of the organism e.g. metabolic enzyme status at time of exposure, nutritional status, general health status, stress level, etc. Toxicological analysis deals with the detection, identification and quantification of xenobiotics in biological systems. A great deal of toxicological knowledge is either based on experimental animal in vivo toxicity testing, in vitro toxicity testing or on epidemiological studies in humans at occasional poisoning cases. As for ethical reasons intoxication experiments cannot be made with humans, publication of observed incidental poisoning cases is therefore essential. It is now well recognized that virtually all toxic effects are caused by changes in specific cellular molecular targets [30,31].

Forensic toxicology deals with the investigations of causes of death, poisoning and inadequate or recreational drug use. Forensic toxicology uses notably analytical chemistry, pharmacology/toxicology and clinical chemistry for these investigations and is mainly focused on the interpretation of the obtained toxicological findings. Forensic toxicologists are specialized scientists basically trained as biologists, chemists, pharmacists, physicians, veterinarians or several of these, who investigate any suspect symptoms recorded, any evidence collected at the scene and determine a concentration or dose/response relationship of the xenobiotic in an individual related to the cause of death, behavioural changes or impairment [32].

Medicines: Forensic medicine today is a large medical field that includes

many subareas. However, generally, when one speaks or thinks about it, one associates it immediately with death, autopsies, and related problems. Yet, this is only part of legal medicine, as new approaches and subspecialties are realized because of the advances in medical sciences and socio-political changes around the world. Forensic anthropology and clinical forensic medicine are perhaps the best examples of these new sciences. The origin of forensic medicine remains lost in a distant past, whenever the principles of medical sciences met those of law and justice. Perhaps it began with the Code of Hammurabi (1792–1750 BCE), which imposed sanctions for errors in medical and surgical practices. The same type of punishment also existed in Persia. Later on, the Visigoths promulgated laws that punished poisoning, infanticide, and homicide [33]. Described as a medical trunk that serves the administration of justice, forensic medicine has different branches. Forensic pathology is probably the most emblematic one. Known in many Latin countries as *tanatology* (from the Greek word *thanatos*, meaning “death’s god”), definitions of forensic pathology are often so broad that they would fit better into forensic medicine as a whole than in this single branch. It is “a branch of medicine that applies the principles and knowledge of the medical sciences in the field of law.” An even larger conception of forensic pathology considers it the study of diseases and injuries of the community, because it involves the knowledge of diagnosis and treatment in every medical specialty, but also requires information in many nonmedical areas, such as chemistry, physics, criminalistics and police sciences, motor vehicle and highway conception, politics, sociology and even the way of life of a society [34].

Entomology: When a person dies and the body is exposed to the elements, who (or what) gets there first? It’s not witnesses or detectives, but flies more specifically, a species called the blow fly. During the bombing of the Murrah Federal Building in Oklahoma City (Terry Nichols and Timothy McVeigh were convicted of the bombing), bodies were buried in the tons of rubble from the collapsed building. Investigators literally followed the flies into the rubble in order to locate many of the bodies. Female blow flies and other insects lay their eggs in decaying flesh and different insects do this at different times. Other insects are such as beetles and wasps attack and feed off the insects and the eggs. Depending on temperature and other environmental factors, this parade of visitors takes place at surprisingly consistent time intervals. By inspecting the corpse, forensic entomologists can give a pretty good estimate of the elapsed time since death and determine whether the body has been at a site for many hours or several days. In addition to the postmortem interval, there is other information that can be gained from studying insects feeding on a corpse. If a person has been poisoned, the flies and other insects will ingest some of the poison. A toxicologist can capture some of these critters, chop them up, and extract the poison and identify it. There are also cases where a person took cocaine and then died. Some of the maggots on the body became abnormally large in size owing to their ingestion of the cocaine [35].

Behaviour science: Forensic psychiatry and psychology have been long contributors to the forensic sciences. As long as there has been crime, people have wrestled with the concept of responsibility. Our laws and those of most other countries have long had provisions for how people who commit crimes and have diminished capacity are treated. If a person is truly insane, can she be held responsible for committing a crime? Although the definitions vary as to what constitutes responsibility, insanity, etc., it falls to forensic psychiatrists and psychologists to examine defendants and render expert opinions to courts. There are real differences between psychiatrists and psychologists. Psychiatry is a medical specialty attained by medical doctors. Psychology is a behavioural science that does not involve medical training. Both have a role to play in determining responsibility for committing crimes [36].

Introduction of Forensic Anthropology

Anthropology is the study of humans. It includes their cultures and their biology. The latter is usually called physical anthropology, although the term “bioanthropology” is more accurate. Forensic anthropology is a specialty within physical anthropology. It involves applications of osteology and skeletal identification to matters involving the law and the public. Forensic anthropologists work with skeletal remains to determine the identity of the

decease. Forensic anthropology is usually defined as the application of the science of physical anthropology to the legal process. The routine scope of the discipline is the identification of skeletonized, badly decomposed, or otherwise unidentified human remains. Quite often, forensic anthropologists are involved in identification of living persons. Recently, the range of interests of forensic anthropology is being expanded, as anthropological expertise is requested in the identification and aging of living individuals: in the past few years specialists applying anthropological knowledge and associated disciplines are involved in aging juvenile perpetrators, identifying individuals taped on video surveillance systems, etc., i.e., it is becoming more interdisciplinary [37,38].

Identification of the individual is usually defined as the determination of a unique personality on the basis of entirety of characteristics distinguishing him/her from other persons. Identification problems are important for legal and humanitarian reasons, in solving criminal cases, problems of inheritance, marital status etc. [39]. A very important question to answer in any death investigation is the identification of the deceased, as it allows his or her family to grieve and settle the decedent’s affairs. Investigation of the death is greatly facilitated when the identity of the decedent is known. Identification is more often problematic in forensic cases because the next of kin may not be available to view the body or if injury, dismemberment, and/or postmortal changes that exacerbate emotional responses or that obscure identifying features may make visual identification or use of other techniques such as fingerprints unreliable or impossible. Positive identification entails scientifically establishing identity through the presence of known unique characteristics. All methods of identification require that a known characteristic of an individual distinguishing him/her from all others be compared with the same characteristic of the unknown decedent. Forensic anthropology centers on the assessment of every aspect of human remains in a medicolegal context for the purpose of establishing identity and, where possible, the cause of death and circumstances surrounding this event [40–42]. Forensic anthropologists frequently work in conjunction with forensic pathologists and forensic odontologists. These specialists are also consulted to investigate and authenticate historic and even prehistoric remains and relics. Forensic anthropology may be extremely helpful in mass disasters, military casualties with considerable skeletal remains or in cases of mass burials. As it also encompasses facial image analysis, forensic anthropology may also provide support to investigations concerning living individuals such as a mix-up of children in a hospital nursery, identification of persons involved in immigration problems or human trafficking, robbers, burglars or thieves recorded by surveillance cameras or occasional witnesses, etc. [43].

History of Forensic Anthropology

Forensic anthropology is a subfield of physical anthropology, and is the application of anthropological theory and method in a forensic, or legal, setting. The field experienced several false starts before it found its niche. What began as criminal anthropology in the nineteenth century, developed into Bertillonage, a system based on anthropometrics that died out by the 1920s? Criminal anthropology was a theory developed by Cesare Lombroso, a physician, who held the belief that every individual is distinguishable by unique anatomical markers, similar to our understanding of fingerprints today. The theory never caught on in the medical community, however, and petered out quickly [44]. Lombroso’s hypothesis that each individual is anatomically unique grew into the practice of anthropometry. Anthropometry is a system of measurements taken with the idea that an individual can be identified based solely on the profile created of their anatomical markers, a crude precursor to modern forensic anthropology. Bertillonage was a system created by Alphonse Bertillon based on this theory, wherein a set system of measurements could be used to identify repeat offenders in the criminal justice system. Bertillonage was widely used by police until the advent of fingerprinting in the late 1800s. Bertillonage was consequently found wanting in a number of respects, and was phased out in favour of latent fingerprint identification [45]. It was not until the 1940s that the Federal Bureau of Investigation began hiring physical anthropologists employed by the Smithsonian Institution as consultants on criminal cases that forensic anthropology began to take hold. Physical anthropologists were recruited to identify war dead at the end of World War II,

and many of these anthropologists published valuable studies on the skeletal remains of soldiers of known age, ancestry, and stature [44].

The field of forensic anthropology developed alongside major changes to the medicolegal system, which deals with legal issues in medicine, beginning in the 1950s and 1960s. Originally, deaths were investigated by coroners. Coroners were usually elected or appointed to office, and often had no medical training. During the 1950s, forensic pathologists increasingly replaced these untrained officials. They brought more extensive knowledge of the types of experts and consultants who could assist with medicolegal investigations, as well as better-staffed offices with larger budgets used to pay for these consultants. Physical anthropologists had a broad knowledge base of skeletal biology and archaeology, and proved to be useful consultants in these investigations. Over the next decade or so, physical anthropologists became increasingly involved in the identification of human remains. Anthropologists J. Lawrence Angel, Wilton Krogman, and T. D. Stewart consulted on a number of cases and helped bring recognition to the field. By 1970, the term "forensic anthropology" was coming into use, and some physical anthropologists began incorporating forensic techniques into their courses and research [46]. In 1972, a Physical Anthropology section was added to the American Academy of Forensic Sciences (AAFS), and in 1977 the American Board of Forensic Anthropologists (ABFA) was founded. Both of these organizations gave increasing credibility to the field, and to the professionals working within this field. The rigorous standards of entry into the ABFA, and the excellent reputation associated with the AAFS, meant that the law enforcement community could have confidence that the consultants hired to investigate cases were well-trained in forensic techniques, rather than simply physical anthropologists that may or may not have ever dealt with human remains, let alone studied identification techniques [47].

For many years, forensic anthropologists made identifications, but were not asked to participate further in criminal investigations. However, with the development of new scientific techniques, and more advanced research on taphonomy, sex and age determination, forensic archaeology, and trauma analysis, the scope of forensic anthropology has changed. With the creation of databases and collections such as the Bass Collection, a collection of skeletons of known identity, which is housed at the University of Tennessee at Knoxville; the Anthropological Research Facility, a plot of land at the University of Tennessee's Knoxville campus dedicated to taphonomic research; the Forensic Data Bank, which contains modern demographic information from thousands of known samples; and For disc, a statistically-based computer program used to aid forensic anthropologists in determining factors like ancestry and sex, physical anthropologists have been able to do in-depth research on all of these topics, and more [48].

Forensic Anthropology in Bones

Bones does a slightly better job than CSI and NCIS in its attempt at accuracy in that there is more delegation of responsibilities. There is a separate FBI agent, forensic anthropologist, forensic pathologist, entomologist, psychologist, and a forensic artist and technology specialist. However, the show still turns its characters into generalists in its own way. The main character, a forensic anthropologist, is partnered with an FBI agent and regularly takes on the duties of an FBI agent, following leads and interrogating suspects [49]. Bones is also slightly more realistic in its use of time, though it does not make an enthusiastic attempt at accuracy. While CSI and NCIS often have their teams solving cases in a matter of hours, Bones stretches its cases out over several days. In reality, it can take weeks, months, or even years to solve homicides, especially when the body has been concealed for a long period of time. Bones, as the only show featuring a forensic anthropologist, carries a special weight with its audience. Because it is based, however loosely, on the life and work of forensic anthropologist Kathy Reichs and the main character in her novels, Dr. Temperance Brennan, there is an expectation that the show will be more accurate than other crime shows. Reichs stated that "if you see technology or you see a methodology, it exists" [50,51]. However, Reichs points out that just because the technology exists does not mean that most, if any, labs have access to that technology, as it is often prohibitively expensive. Viewers cannot always determine if labs have access to certain types of

equipment, making it difficult to determine whether the methodology seen on the show is something they should expect to see in a court of law. There are several forensic anthropologists featured in rotation on the show in addition to Dr. Brennan. Each is an intern working toward a PhD in anthropology, with the exception of two past interns who received their doctorates and went on to work for the Jeffersonian. The interns are portrayed as the most promising scientists in the field, and Brennan is unequivocally the best forensic anthropologist in the world [52]. It is stated several times throughout the series that Brennan is a genius, and a very accomplished anthropologist. She holds three doctorates in anthropology, forensic anthropology, and kinesiology, is a New York Times best-selling author, and speaks several languages. There has not been a case mentioned or shown in an episode that Brennan has not been able to solve, nor a set of remains she and her team have been unable to identify. This portrayal creates unrealistic standards for success for real-life forensic anthropologists, giving the audience the impression that not only is identification possible in every single case; it is something that can be done in a matter of hours or days [53].

Another issue involving the show's accuracy comes from Brennan being far more certain of identifying features found on sets of remains than is realistic. Although Brennan takes pride in the accuracy of her work, the show often saves time in each episode by having her make determinations that a forensic anthropologist should not make. Brennan regularly makes determinations of age and sex based on a single landmark, or a brief visual observation while performing field recovery. In the episode "The Friend in the Need" (2013), Brennan determines the sex of the victim based on a brief visual observation of the gonial angle of the mandible while performing initial processing of the remains. Case studies show that in some instances sex determination is not quite so straightforward. Most rely on Fordisc to check their determinations of age, sex, ancestry, and stature, and do not decide those things based on a single landmark [54]. In addition to solving cases, which is the overwhelming focus of the show, Bones also featured two episodes centred on the trial process. Because most episodes end with a criminal's confession, there is no need to follow the case to trial. These two episodes are interesting because they allow us to observe a rarely seen continuation of the duties of a forensic anthropologist: testifying in court. The two trial episodes feature crimes with which the team, especially Brennan, is intimately involved. Because of the unusually high rate of success that forensic scientists experience on television shows, viewers do not often get the opportunity to see the trial take place. While forensic anthropology's media presence is already limited and highly dramatized, its court presence is almost non-existent, restricted to these few episodes of Bones and highly publicized cases like the Casey Anthony murder trial [55].

Familiarity and Importance of Forensic Science and Forensic Anthropology

Most respondents feel that forensic science plays a significant role in criminal trials, reporting an average score of 7.2 out of 10 in terms of importance, with 10 being "very important." No non-jurors chose a score of one or two, or "not important." Interestingly, respondents were more mixed about the role of forensic anthropology, reporting an average score of 6.38 out of 10. This lower average score may be due, in part, to the fact that forensic anthropology has relatively little media visibility compared to other forensic sciences. If the public is less exposed to this field, they may perceive it as less important than fields like forensic entomology or chemistry, which are far more ubiquitous. Overall, however, participants feel it is more important than not. When asked about deciding on a verdict based on evidence, 39.8% of respondents indicated that they could vote guilty with little forensic evidence, despite their expectations for evidence being much higher [53,54]. However, when asked how much evidence would be necessary in order for participants to make an informed decision, respondents overwhelmingly indicated that they would require a lot of evidence to be satisfied: 75.3% scored seven or higher out of 10, with 17.98% reporting a score of 10. When asked if they would be more or less inclined to vote guilty if there was a lot of forensic evidence, only two participants said they would be less inclined to do so. Most respondents

feel forensic science is quite reliable as a means of analyzing evidence, but do not believe it is perfect. Forensic anthropology was seen as slightly less reliable, though the majority of participants gave each of the two questions a score of eight out of ten. When asked how often forensic science should be used in criminal cases, most participants indicated that it should be used most or all of the time [55] (Figure 1).

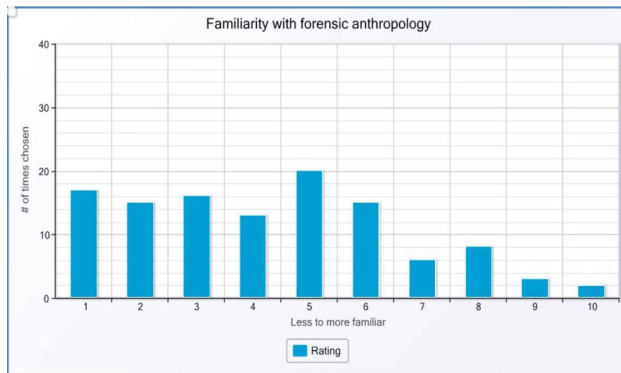


Figure 1. Familiarity with forensic anthropology.

Participants indicated at least some need for forensic science, with all participants scoring three or higher on a scale of one to ten, with one indicating that forensic science is “never necessary” and ten indicating that forensic science is “always necessary.” Over half of respondents (51.1%) scored eight or higher on this question. Participants were asked to rate their familiarity with the field of forensic anthropology on a scale from one to ten, with one being completely unfamiliar and ten being very familiar. Responses leaned overwhelmingly towards the ‘less familiar’ end of the spectrum, with 96 participants (83.5%) rating themselves six or lower, out of which 61 participants (53%) rated themselves four or lower. Only two respondents reported a score of ten, or very familiar. When asked if respondents knew the difference between science and anthropology as general fields, and forensic science and forensic anthropology, several participants indicated a lack of knowledge of the fields to varying degrees. Out of 92 responses to the question, nine said they did not know. Six participants indicated that forensic science deals mainly with DNA and particulates. Several respondents said forensic science deals only with the deceased, implying that it would not apply to other crimes, such as assault, rape, or theft. Others indicated the difference between science as a whole and the more specific field of forensic science, but could not do the same for anthropology, or knew what anthropology was but could not articulate how forensic anthropology was different or did not know what forensic anthropology was [56,57].

The Crime Scene Investigation (CSI) Effect

Forensic science is portrayed on television as infallible, definitive, and unimpeachable. Forensic scientists are heroes fighting for justice in the wake of tragedy. In reality, forensic science is imperfect, as are the scientists that perform it. The disparity between what is shown in the media and what actually happens is where the CSI Effect comes into play. The majority of Americans are not well-versed in the intricacies of scientific testing; even attorneys and judges often do not have a strong knowledge of what a reliable scientific test looks like, simply because they have not studied any of the fields under the wide umbrella of ‘forensic science’ [58]. The term “CSI Effect” began to appear in the media by 2005 as a largely psychology-based theory. It can be most broadly described as the potentially negative result of a person not understanding the difference between the science shown in the media and the science used in real life. The definition of the CSI Effect becomes murkier the more specific it becomes, as many who have studied it have come up with definitions of their own, some of which directly contradict others. The CSI Effect can be described in two seemingly opposing ways. The first description approaches the CSI Effect as a negative for the prosecution, saying that the more people watch crime shows, the more physical evidence they expect at trial. When that evidence is not presented, as is often the case, jurors are disappointed and

feels the burden of proof has not been met. The second approach says that because the science on these types of shows is presented as infallible and unequivocal, any physical evidence presented in court will be viewed the same way by jurors who have watched the shows. Ultimately, the theory is based on forensic science: what it entails, its accuracy, its portrayal on television, and the jury’s familiarity with all of those things [59,60].

Forensic science as it exists in reality has recently been at odds with its TV portrayal. While shows like *Bones* give the science an air of unshakeable certainty, landmark court cases have led courts to determine that these supposedly unimpeachable methods of testing are not as reliable as previously thought by Schweitzer & Saks in 2007. Cases such as *Daubert v. Merrell Dow Pharmaceuticals, Inc.* in 1993 and *Kumho Tire Co. v. Carmichael* in 1999 set new standards for the admissibility of evidence and expert testimony. *Daubert* led to stricter standards for evidence and expert testimony, and *Kumho* expanded on the so-called ‘Daubert standard’ to include technical evidence in addition to scientific evidence. Because of these stricter standards, courts have more closely scrutinized the evidence submitted for trial and found much of it wanting. Methods of scientific testing, like fingerprint and handwriting identification, have been found to be far more equivocal than originally thought. Despite these discoveries, forensic science is depicted on TV as accurate as long as the latest technology is employed, and the evidence will always point to the guilty party. In fact, the latest technology may not even meet the *Daubert* standard, as it may not have been adequately tested or peer-reviewed in order to meet the ruling judge’s threshold for admissibility [61,62]. The study was comprised of 48 college students with varying experience watching crime shows, which completed a questionnaire based on fake trial transcripts where a single hair was the prosecution’s most important evidence. The study concluded that those who watched crime shows were more likely to be critical of forensic evidence than those who did not. In addition, viewers rated themselves as having a better understanding of what a forensic scientist does than non-viewers, and expressed more confidence in their verdicts. However, the difference in verdicts rendered by each group of participants was not statistically significant, though viewers were slightly less likely than non-viewers to return a guilty verdict. The authors of the study concluded that crime shows do have an effect on jurors, and may lead them to expect more high-tech evidence at trial [63].

Complementing the idea of the CSI Effect is the question of whether jurors are able to disregard or compartmentalize information. If a juror is unable to separate unrelated or irrelevant information from the pertinent facts as directed by a judge during a trial, then inability to compartmentalize may carry over into influences from television shows and the wider media. Several psychological studies on juror bias and concluded that most jurors are unable to disregard information, even after a judge has ordered them not to consider it in their decisions. Tyler posits that the practice of questioning jurors about their television viewing habits may be enough to influence a jury, and that jurors may be prejudiced by the mass media even when the legal system makes an effort to prevent such preconceptions from colouring jurors’ judgment [64]. One study that tested for the presence of the CSI Effect among over 2,200 randomly selected jurors in Michigan failed to prove that those who watch crime procedurals were more likely to require forensic evidence for a conviction. The study suggests instead that jurors might be affected by a broader “tech effect” wherein the more technologically advanced our society becomes; the more jurors will expect to see similar advances in forensic science and thus expect more and better evidence in court. However, the study cautions against too much weight being given to any one source, whether it be crime shows, the media as a whole, or technology, because all three play important roles in how jurors perceive forensic science and how they make decisions during a trial [65].

Despite a lack of evidence in support of a supposed CSI Effect affecting jurors’ decisions during trial, it is important to consider how crime shows might be impacting other participants in the criminal justice system. Through the news media and several studies on the CSI Effect as it relates to jurors, it has become apparent that police, attorneys, judges, and criminals are in fact the ones most strongly affected by the CSI Effect. There is still plenty of room for investigation into how crime shows, in tandem with the media as a whole

and Shelton's "tech effect," impact jurors' perceptions of the various subfields of forensic science and their decisions during trial. However, one must also consider the possibility that jurors are not the target of the CSI Effect, and that perhaps more research should be devoted to how crime shows influence everyone in the legal system leading up to jury selection [66].

Case Study: O.J. Simpson Murder Trial

Orenthal James Simpson was tried in 1995 for the murders of his ex-wife, Nicole Brown Simpson and her friend, Ronald Goldman. The entire case saturated the news media and held the attention of the entire world from the murders in June of 1994 until the end of the civil trial in February of 1997. Despite ample forensic evidence and witness testimony, the jury returned a stunning "not guilty" verdict, shocking nearly everyone watching the live coverage. When the police notified Nicole Brown Simpson's family that she had been killed, the news did not seem to come as a surprise to her sister, Denise Brown. A neighbour had found Brown's body shortly after midnight on June 13, 1994 and called the police. When police arrived on the scene, they found her, as well as an unidentified man, brutally slain just outside her condominium in western Los Angeles, California. Scattered around the bodies were several pieces of evidence, including a left-hand brown leather glove and a trail of bloody footprints leading away from the bodies [67,68]. Brown had two children during her marriage to Simpson, who were found sleeping inside. One of the lead detectives, Phillip Vannatter decided to notify Simpson so he could take custody of the children while the scene was being processed. The lack of a response from the estate's inhabitants, combined with the crime scene and Brown's connection to Simpson gave investigators cause to enter the property without a warrant [69].

The investigators were finally able to get in contact with Simpson, who said he would be on the next plane back to Los Angeles, but did not ask for any details about the crime. Detectives discovered what appeared to be a matching right-hand glove behind Kaelin's guest house, as well as more suspected blood droplets near two other cars parked in the driveway, and a trail of blood leading from the Ford Bronco to the front door of Simpson's house. Detective Vannatter then declared the Simpson estate a linked crime scene to the double homicide and quarantined the entire property until it could be processed. Dennis Fung, the criminalist responsible for cataloguing all evidence related to the case, collected several pieces of evidence, including a bloody sock, which would become a contested item during the trial [70]. Back at the primary crime scene, Fung catalogued additional evidence, including keys, a beeper and the single leather glove. Much of the evidence, though catalogued by Fung was discovered by Detective Mark Fuhrman. The coroner's investigator examined the bodies and determined that Brown was likely killed first, followed by the male, who was identified as Ronald Goldman, a close friend of Brown's. Dr. Irwin Golden, deputy medical examiner for L.A. County, performed autopsies on both victims. He found contusions caused by blunt force trauma on the backs of both victims' heads, as well as several stab wounds on the victims' bodies. Brown had four deep penetration wounds, and defensive wounds on her hands. Her throat was slashed almost to the point of decapitation. Goldman had 19 knife wounds in a pattern indicating a "frenzied attack," four of which proved fatal [71]. Blood samples from both victims were taken to the Los Angeles Police Department serology unit, in the Scientific Investigation Division (SID), where all but the most complicated tests would be run. SID mostly focused on polymerase chain reaction (PCR) DNA testing, which is used to compare samples and eliminate suspects. RFLP testing can identify a single individual out of billions, to the point of excluding the rest of the world's population. Simpson eventually arrived back in L.A. and returned to his home. Lead Detective Tom Lange asked officers to detain him upon his arrival, but not to arrest him, as there was not yet enough evidence against him. The initial interview was short, but Simpson contradicted his story several times. Investigators managed to persuade Simpson to provide fingerprints, a photograph of the wound, and a blood sample to the police. The blood sample played an important role in the trial for a number of reasons. The nurse who took the sample testified in a preliminary hearing that he drew eight cubic centimetres of blood. In reality, he drew 6.5 cc; the 8 cc he testified to

was merely an estimate. However, the defence used the discrepancy to their advantage, claiming it was part of a conspiracy by police to frame Simpson for the double homicide [72-74].

Law enforcement ordered the men to stop the car, but Cowling called 911 and informed them that Simpson was suicidal and had a gun to his head and that they would not stop. A slow chase proceeded, with the Bronco travelling at approximately 40 miles per hour along the interstate. The chase was one of the most watched news stories in history, with viewership nearing that of the moon landing [75]. Eventually, authorities convinced Simpson to surrender himself at his home, where he was arrested. Much was made of the decision to move the trial, as the jury pool in Santa Monica would have been mostly white, while the jury pool in downtown L.A. was mostly black. Ultimately, the jury consisted of ten women and two men, of whom nine were black, one was Hispanic, and two were white [76,77]. Blood found at the primary crime scene belonged to Brown, Goldman, and Simpson. The defence alleged that Simpson's blood had been planted at this scene as well. They based this argument on the fact that bloodstains were found on paper wrapping that supposedly contained dry blood samples and that the injury to Simpson's finger was not large enough to have bled in the amounts found at the scene. As for the shoe prints, the defence argued that no matching shoes were ever found, and that thousands of the same type of shoe had been purchased [78]. Finally, the prosecution pointed out that Simpson did not have a verifiable alibi for the time of the murder. The murders were determined to have occurred between 10:15 and 10:40 PM. Simpson would have had plenty of time to commit the crime between the last time Kato Kaelin had seen him, and the time he greeted his driver to take him to the airport. The defence argued that Simpson did not have time to do everything the prosecution claimed he did, instead asserting that Simpson was at home the entire time after deliberating only four hours, the jury returned the stunning verdict of not guilty. The verdict shocked those who had been following the trial. The LAPD had prepared for riots, lining the streets with police officers. Many believed defence counsel, who had put on a show at trial, had swayed the jurors [79,80].

Discussion

Crime shows create unrealistic standards of success for forensic scientists and law enforcement. So, nowadays forensic science is a need to quickly investigate the crime and to solve it without wasting any time. By using different techniques of forensic sciences, the time is consuming less for investigation. By using different techniques, the forensic experts will get accurate result. By the literature review, it has been proven that the forensic anthropology is an important part of the forensic science. The crime is always going to pass through the various techniques of the anthropology. With that the investigation makes easy and conclude accurate result. By detecting the physical evidences, the investigators can take that as a lead from the crime scene and proceed for the further. It has been also proven that there are so many people who do not know and they have no idea about the forensic anthropology. The CSI franchise portrays evidence collection as a reliable way to quickly solve a crime. In reality, the evidence does not always tell as much of the story as the show would have viewers believe. It takes a great deal more work by the police to solve crimes by employing more traditional methods, such as questioning suspects and witnesses and following leads. The literature survey will give the idea of forensic anthropology and study the connection between forensic science and forensic anthropology. It has also taught the importance of forensic science and their different branches, which can be very useful for crime investigation. The O.J. Simpson case is an example of the pre-CSI jury, which had little to no familiarity with forensic science and therefore had to rely on complicated and conflicting accounts of the significance of the evidence in the case. The O.J. Simpson trials have a great deal: It was considered the trials of their respective centuries, it concluded with unexpected acquittals and involved defences based on poking holes in the prosecution's case. The trials differ, however, in the amount and types of forensic evidence presented and in the makeup of the juries. The O.J. Simpson case featured a mountain of forensic evidence and witness testimony. DNA evidence was presented tying

Simpson to the scene and the victims, and witness testimony supported the prosecution's timeline of the crime.

Conclusion

Forensic science is that piece without which the puzzle of a criminal investigation is incomplete. Without the application of forensic science, criminals can never be convicted unless an eyewitness is present. While detectives and law enforcement agencies are involved in the collection of evidence, be it physical or digital, it is forensic science that deals with the analysis of those evidence in order to establish facts admissible in the court of law. Thus in a world devoid of forensic science, murderers, thieves, drug traffickers and rapists would be roaming scot-free. The duties and responsibilities of a forensic scientist in a criminal investigation are crucial as it involves the careful examination of evidence while ensuring that it is not tampered with. A diverse pool of forensic scientists and forensic tools go into the investigation of a criminal act. It also explains different branches of forensic science including forensic anthropology. Forensic science and forensic anthropology have been introduced to the public over the last two decades largely through the lens of the media. The O.J. Simpson trial brought the importance of forensic evidence to the forefront of the public's mind, and television shows like CSI have kept it there. The media has been heavily saturated by crime procedurals and news stories focused on forensic evidence, crimes and court cases.

These studies raise an important question: if there is such a complete lack of empirical evidence supporting this theory, then why does it persist? It seems that more research needs to be done on the CSI Effect, but not necessarily on jurors alone. Attorneys, criminals, judges, and law enforcement all appear to be far more affected by crime shows than jurors. Police make a greater effort to collect and analyze evidence, which has positive and negative effects. The police are working harder to make sure the correct party is found guilty, but this has resulted in the entire legal system slowing down because of backlogs at testing facilities. Ultimately, the importance of the CSI Effect comes down to two questions: does it actually matter if CSI Effect exists, or does it only matter if people believe it exists? And if it only matters if people believe it exists, does that, in fact, force the CSI Effect into existence, but in a different way than we expected? If attorneys, judges, criminals, and police are the ones most concerned about the CSI Effect, then researchers may be approaching the topic from the wrong angle. It may be that the CSI Effect exists, but that it does not appear affect jurors with the same impact as everyone else in the legal system.

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How to cite this article: Pranav Y Dave. "A Path of Sympathetic to the Forensic Science from the Sight of Forensic Anthropology" *J Forensic Res* 12 (2021) 12