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REVIEW

CASE REPORTS

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Review on the Individual Identification of Human Hair Morphology for Retrospect and Prospect

Abstract In 1837, Brewster optical microscope for the first time the specificity of the surface structure of hair was found. With several new technologies in practice the application of the morphological structure of the hair, the gradual deepening, hair morphology of research results are widely used in the field of individual identification of forensic science, in some developed countries for individual identification of hair has become a fixed the guiding principles and application guidelines. In recent years, with the high-tech developments, such as atomic force microscope and other applications, morphological structure of hair into the micro-, ultra-micro-level, and conducted quantitative research, which makes the hair on the validity of the identification of individual identification was confirmed. In this paper, the individual identification of hair morphology of research progress at home and abroad are reviewed.

Keywords: Forensic science; Individual identification; Human hair; Morphology; Review;

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1. The basic structure of human hair morphology

Of human hair into long hair (hair, beard, armpit, pubic hair), Short-haired (eyelashes, eyebrows, nose hair, ear canal Short-haired), vellus hair, lanugo 4. Short-haired long-haired, and the final synthesis of hair, is characterized by rough and hard, color and thick, with medulla and melanocytes. Vellus hair soft without the medulla, shorter, most no more than 2cm, can have lighter pigments, are found in addition to the Ministry of palms and soles, vermilion, nipples, glans penis, clitoris and finger (toe) Distal outside the body. Lanugo soft, thin, no pigment, no medulla. In humans, hair growth and replacement is through a growth phase (active phase) (anagen), transitional phase (catagen) (catagen) and resting stage (telogen) continuous process [1]. Final hair by hair shaft, hair root, hair follicles (1) medulla: is located in the center of hair is determined by loosely arranged polygonal marrow cellularity; the arrangement and the present pattern due to the different types of hair while a wide range of performance, the role of a classification. (2) hair cortex: is a close parallel to the longitudinal axis with the hair arranged in long, slender spindle cells. (3) hair cuticle (also known as flake): It is the most appearance of hair cover, the ground layer to the multi-storey flat keratinized cells in a transparent composition, was coronal, petal-like, corrugated-shaped surface such as a variety of form [2]. The end of the hair root enlargement was spherical, that hair bulb. The microstructure of hair depends primarily on congenital, with species-specific; the same time, due to function and adapt to the same or different, will also show the corresponding general character and individuality. So that the microstructure of hair to show complexity.

2. Individual recognition of human hair

The 20th century, 20 to 30 years, with optical microscope based on morphological structure of the first phase of the hair. In 1920, the United States issued a mammal Hausman coat of micro-features, the first time that the microstructure of the existence of gross differences between species, there has been Taxonomic Significance. And the hair is divided into three ethnic groups (Caucasian whites, blacks, Mongolians), etc.. Trotter, M study of this period in different age, sex, ethnic characteristics of beard; white Americans, the French, Canadians, Iraq and the Arabs hair characteristics. Application of research results began to criminal investigation. This period of preparation method of a number of hair samples also gradually improved. The 20th century, 40 ~ 90 years, especially 70 years or so, the application of electron microscopy, the hair on the whole body multi-angle, multi-level, a study [3], such as different ages, different sexes, different parts of the difference between the hair. But these details of the research results transferred to the forensic practice, no system coverage. There are research reports of hair identification of possible deviations in [4]. In 1982, the United States was established by Barry Gaudette Chairman of forensic science hair test evaluation committee [5], so that this stage of identification and appraisal of individual hair peaked. In 1991, Teerink published in "Hair of West European Mammals" book is about the hair, the most systematic study of the writings, systematically expounded the species identification of hair, the principles, methods and should pay attention to the problems [6].

The past 20 years, is the third phase of the study of hair, this time due to the extensive application of molecular biology techniques, many scholars turned to the study of hair, DNA and mtDNA. But the novel nano-high-resolution microscopes, such as atomic force microscope (AFM), micro-diffraction techniques applied to the micro world, the morphological structure of hair gradually to a deeper mystery of space development. In 1986, Binnig and Rohrer invented scanning tunneling microscope (STM) and atomic force microscope (AFM). In recent years, STM and AFM have been in the life sciences, microelectronics and nano-technology and other fields has been widely used. Since 1994, the first reported study using AFM hair started [7], AFM is considered a non-invasive detection of the hair surface, the ideal technology, which provides greater clarity than the SEM and TEM images of the epidermis. Smith,JR step Smith, JR related software with the AFM images of the AFM quantitative, digital analysis, such as the hair of small skin-related data: the high step (step height), tilt angle (tilt), the dorsal angle (backtilt), spacing (layer spacing), surface distance (face distance), at the top of the distance (top distance), the error match (fit error), hair density of small skin (cuticle density), hardness (roughness) and matching ratio (fitability) measurements and calculations, and using least-squares method, cluster analysis, statistical analysis software, can the majority of samples (86%) were correctly classified [8]. AFM probe measurement area of 20 × 20 η m of the plane, while the hair is round, a long linear structure. To be able to repeat the study of hair in the same location, reduce the position errors caused by round, some scholars studied the

correction factor [8], and adjust the scanning range, so that repeated AFM scans before and after the return to the same location [9]. Sato H [10] conducted a study of the Japanese hair that hair in the intra-individual variation between the small and individual variation, which is conducive to comparative morphology of hair done by personal identification. And get a great deal more on the hair morphology of large amounts of data, which will be conducive to the establishment of a hair test analysis system. Verma MS [11] demonstrated the use of such NNESs (neural network explanation systems) carried out the feasibility of personal identification of hair. The NNESs, simply enter the 21 micro-structural characteristics of the five, will be to determine whether the two from the same individual. Method has been applied can be done should be 83% of the match rate. Human hair has traditionally divided into three categories according to national characteristics, that is mentioned earlier, the Caucasus whites, blacks, Mongolians, with straight, wave, roll, knot, rotating the words name, but this does not apply the points system has been one the world's brings the situation. De la Mettrie R [12] without regard to race differences, the hair on the worldwide research carried out, with curly diameter, curl index, wave number and the number of targets circled, with the main component analysis software to the hair is divided into eight categories, which than the traditional classification by name more specific and accurate. Russian scientists studied dozens of countries on four continents hair micro-and macro-morphological characteristics, improve the knowledge base of the hair around the world.

In 2004, the U.S. court issued a scientific exchange on the hair analysis identification guides and operating manuals, including animal and human hair identification of two parts [13-14]. Application comparison microscope and the microscope right hair color race, hair little skin, cortex and medulla, hair dry, hair root, hair shaft shuttle, pigment granules type and physical characteristics of different parts of the hair comparison, and gives micrographs ; how to distinguish animal hair and human hair; people dealing with hair, such as bleaching, dyeing and other characteristics; cutting, shaving, smashing, burning and other external force upon the performance of the hair; the tools of regulation and sample preparation. Through the above indicators are known and unknown hair hair than the right, arrive at the same determined. The United States and identified specific hair McCrone company's responsible person Richard E Bisbing in 2007, to the Professional Committee of the Association of Forensic Science presenting with hair than the standard, quality assurance, personnel training and requirements [15]. He referred to the inspection staff must receive at least a bachelor's degree in natural sciences and applied sciences; technical guidance must be related to a professional master's or Ph.D. and at least five years experience in trace evidence examination; or access to natural and Bachelor of Applied Science With a degree in the five-year examination of trace evidence examination of the experience, through the courts found that the legal procedures of science or a registered laboratory examinations, and advanced courses in the microscope to achieve good results before they can become a technical guidance. Pointed out that the identification of hair and test the effectiveness of work experience who have a direct relationship.

Domestically, the shape of the hair, and individual identification studies late in 1963, Mr. Peter published a China back hair first mammal research articles [16], followed by the hair, the study reported increased gradually. Foreign-based basic research, at the outset tend to application stage, such as mammals, the differences between the kinds of characteristics and identification. In 1983, Zhan re-million in the anatomy of the newspaper published her first normal hair and scanning electron microscope, began the study of human hair morphology, but only limited to the surface of gross morphological structure of small skin type, and is divided into six categories, for the observed differences between sex and age [17]. Later, China had more than a dozen research articles on hair shape, focusing on the study of Mao's little skin, trying to sort through the hair of small skin, studies have normal fetus, different nationalities, different parts of the hair-like surface morphology and longevity for the elderly hair characteristics, this paper has the shape of Mao's description of the small skin. These studies focused on the analysis of subtle form of clutter-type scales, while ignoring the causes of these scale forms, so it does not achieve the expected results. In 1988, Wang Wei and other various parts of the hair of normal adults, a small skin hair done morphometry studies, for hair in forensic science in personal identification applications can be found in the data. However, small sample size, not necessarily representative. Hsu Wen-Long [18] observed the 91 cross-sectional characteristics of Chinese human hair, including short track, long track, cross-sectional index and cross-sectional area, and with other ethnic groups were compared. Found that Chinese people the most coarse hair, cross-sectional shape, closer to the circular, the only long diameter was significantly smaller than

blacks, but also on the characteristics of the hair cross-section of gender differences and individual differences were analyzed. And based on the results of forensic tests in the morphology of hair put forward a preliminary comments. And in 1992, wrote "Hair testing and individual identification," explained hair morphology, structure, function, disease changes, which are detailed on hair testing a variety of techniques and methods of work, and proposed mechanism of hair damage insights. In 1998, Ding Min-Ju [19] using scanning electron microscopy of human hair tip micro-morphological characteristics, summarized several parts of the body hair tip the main form of the eight types: blunt-po head type, sub-again type, flush type, no scale type, oblique mouth, irregular type, needle type and conical; into different aspects of Tippy the possible shape of the formation conditions of regularity of the distribution, as well as the Ministry of pruning back-end changes, there is a great practical significance, for the hair adds an indicator than the right.

Into the 21st century, due to DNA and mtDNA testing in hair is widely used in individual identification, the morphology of hair and fewer and fewer reports of individual identification. There are several normal hair introduction of scanning electron microscopy features and changes in hair for adults of different ages, measuring the diameter of the hair, growth, density, etc., used to assess the population aging and health. There are a few disease-related changes in hair morphology reported [20], but it is also limited to gross morphological changes of the small skin. Hair in the forensic application and progress of the review, including with the hair all the relevant content, such as trace elements, organic compounds, biological testing (DNA, ABO blood type, protein, mtDNA, etc.) [21]. In recent years, national reports on hair is also focused on the content. Has published several books and hair-related [1,22], of which there are some elements, such as different ethnic groups, occupation, region, age, individual differences in trace elements in hair can be used to identify you personally.

The foregoing findings, the domestic research on hair late, and did not form a system of inspection and analysis of identification procedures. For the morphology studies confined to surface structure. Abroad on hair morphology studies have been deep into the nano-scale structure, and and practice, promoting a variety of disciplines. Individual Recognition of shape from the initial structure of a gradual shift of quantitative research, some scholars predict that, with in-depth study of hair in individual identification will play a greater role.

3. Individual identification of human hair morphology research prospects

Hair is the most accessible, most easily stored biological samples. Normal day, there are dozens to more than 100 natural shedding hair root, with the criminals, anti-detection capabilities, criminals to destroy the scene after committing the crime, destruction of physical evidence and other means to make the scene of many criminal cases, there may not be any other physical evidence left behind and only one or hairs, hair in the investigation of such cases becomes more important, the identification of hair the result will directly affect the investigation of cases.

3.1 The morphological structure of hair identification of individuals

Hair can come off naturally or by external factors which led to unnatural shedding. In the homicide, assault, rape or other criminal cases, since the parties between individuals directly or indirectly contact, scuffle, friction, weapon combat and so on, may make the offender or the victim's hair left at the scene, attached to the weapon or the victim's such as underwear and body parts, thus becoming the crime scene evidence. Hair detection of such trace evidence forensic examiner should be attention to study the shape of hair can be a number of important information (yes hair or textiles or other things, whether human hair, what type of animal, whether from false hair, that race, that the body parts, hair color, is broken pinched or cut, hair cut the way, if burnt, would have been bleached or dyed, is forced avulsion, whether derived from the suspect, whether to do DNA analysis, etc.), some information on DNA analysis is not available. The intrinsic characteristics of hair can be used to trace evidence such as hair constantly falling from the body, is evidence of a person's unique, hair easy to discover, can be used as evidence of permanent preservation, the hair contains the DNA and so on. These are other biological specimens difficult to achieve.

3.2 The establishment of specialized hair micro-structure, testing accreditation body

As opposed to DNA testing, micro-morphological evidence of hair was considered too subjective, the lack of scientific evidence and scientific rigor applied in the absence of established guidelines has been widely criticized. The reason leading to this result are manifold. One very important reason, or fails to recognize the importance of hair as evidence. NDNA and mtDNA analysis of hair can not be denied

the individual identification of the role, but also has its limitations: the hair found at the scene may be too much, to full analysis of DNA, will inevitably bring about unnecessary waste of resources; also have a lot of hair, can not be extracted to the DNA; mtDNA is maternally inherited, there are differences with the mother the possibility of the child; a lot of hair as evidence of the microscopic characteristics of DNA analysis can not be. Therefore, in DNA analysis techniques mature, it is necessary to re-establish the micro characteristics of the hair as evidence in confidence. But to get the court recognized, there must be a clear identification of the test criteria (such as: How to sampling and selection of materials, what tools or methods to test the eligibility certification, quality assurance testing to identify the validity of the results, etc.). The implementation and enforcement of these standards must be developed jointly by a senior expert, and to monitor implementation. At the same time, we must recognize the limitations of hair testing and the recognition of the uncertainty of test results, leading to uncertainty for many reasons: too few samples of known and unknown hair samples of hair similarities exist and can not explain the non-similarity has been Inspection of the microscopic hair samples do not have enough features (such as: fracture, fragment, short, colorless, fuzzy, etc.). Therefore, morphological examination of hair, DNA testing must be combined, in the identification of complement each other in order to maximize the potential of science to explore the value of the cases detected in the hair, will play an important role.

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Review on the Clinical Application of Gait Analysis

Abstract Gait analysis is a method of studying walking rules. It is an important part of functional evaluation of low extremity. This article reviewed two kinds of gait analysis methods and their advantages and disadvantages. Their advance and application in our country would be included..

Keywords: Gait; Gait analysis; Rehabilitation evaluation; Review;

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Introduction

Walk dysfunction is one of the factors that affects patient capacity of the daily independent living and needs to be restored urgently. With the increased incidence of cerebrovascular disease, accidents and injuries year on year, there will be a large number of patients with lower limb dysfunction need for rehabilitation now and in the future.

Before and after treatment in the rehabilitation, it needs an objective, scientific assessment of the state of the lower limb function to understand the function of lower limbs and the effect of the rehabilitation therapy. Gait analysis (GA) is the study of walk way to check on foot, lower limb function, and is an important part of assessment. By means of biomechanics and kinematics, it can not only reveal abnormal gait and key factors to guide the rehabilitation assessment and treatment, but also help the clinical diagnosis, assessment of efficacy and mechanism research [1]. The purpose of gait analysis is to identify the mechanisms and causes of abnormal gait, to access to quantitative gait data, to select the optimal treatment strategies and to evaluate rehabilitation treatment [2].

1. Gait analysis

1.1. Qualitative analysis

The physician observe patients visually in the joints, muscles, pelvic movement and posture coordination in three directions from the front, the rear and the side during walk [3]. Visual method is simple and suitable for all levels of medical institutions, and is a systematic functional assessment of gait before the necessary evaluation. But this method is not quantitative but often a strong subjective, and because of the complexity of the human gait, diversity, and different therapists that there is a big limitation of its clinical application.

1.2. Quantitative analysis

It is a quantitative inspection and analysis method for visual description of limb movements during walking, and provides an effective way for clinical assessment of lower extremity functional status.

1.2.1. Kinematic Analysis

Get hip, knee, ankle and pelvic movement angles by pasting reflective signs at the surface of joints with 4-6 cameras getting trajectories of walking landmarks. Use the internal axis and Euler rotation angles to describe the three-dimensional motion of the joints during walking [4].

Kinematic parameters include: pelvic tilt and rotation angle; hip flexion, abduction and adduction angle; knee flexion and abduction angle; ankle dorsiflexion and toe flexion angle; and toe range of motion. They have been used to describe and compare the types of pathological gait [5]. However, this method is complex and time-consuming and difficult in clinical use that they have been more chosen by scientific researchers [2].

1.2.2. Kinetics analysis

It includes the pressure analysis and load analysis during the movement. Two force plates have been used to measure the plantar pressure distribution and the ground reaction force in the support phase of walking, including the vertical stress, the horizontal and lateral shear and the plantar force area. In addition, there is a specially equipped inner sensor in the shoe which can measure the plantar pressure on different parts of [2]. But this method cannot obtain the walking space variables.

1.2.3. Temporal-spatial analysis

Walking time - space variables can be obtained through the footprint method that the sole of the foot coated with ink should walk through the pedestrian access (typically 4-6m) covered with white paper [6] or with pulverized lime [7]. Times have been recorded by the stopwatch. Walking variables of step length, stride length and step width can be obtained from footprints. Although the footprint method is simple and quantitative, it is lack of accuracy and cumbersome for the testing process that it is difficult to be accepted in clinical practice. Now the electronic walk pad inserted with baroreceptor can record the real-time walking variables. It can measure time - space variables such as the single foot / feet support time, swing time and pace, etc. [8] in addition to the above. By comparing with gait analyzing results of the normal or the pre-treatment, it can access the type of pathological gait and treatment effects for further clinic treatment. This method can collect real-time walk parameters, and is objective, quantitative and accurate that it can be used as simple and sensitive indicators of clinical application.

1.2.4. Dynamic electromyography (EMG)

It is an effective method to detect muscle activity during walking. It can analyze and record the time and intensity of the muscle activity. The superficial muscle should use the surface electrodes while the deep muscle the implanted wire electrode [2]. This method is targeted and is a very important significance for abnormal gait, nerve and muscle of specific causes. But since the high check cost, it is difficult to be widely accepted.

1.2.5. Oxygen consumption

To analyze of human walking energy consumption, subjects should wear a portable oxygen analyzer. The exhaled gas should be

collected during walking to do oxygen consumption analysis which be to do division with the walking distance: the lower the oxygen cost, the smaller the energy consumption for walking [9]. It is often used to detect the oxygen consumption during walking under prostheses, orthoses or various pathological conditions [2]. It can be used as a sensitive indicator for assessment of rehabilitation efficacy and brace usage. The gold standard for any walking training is to reduce the effect of oxygen consumption, therefore, the oxygen consumption will be a very promising technique in the future [10].

2. Clinical application

Many damaged systems will result in gait abnormalities, such as the nervous system, musculoskeletal system, etc. [2]. Gait analysis has an important role in the cause analysis and diagnosis of human motion and nervous system disease, and in the assessment of interventions [11]. Rosano et al [12] have done the gait analysis and MRI on the 220 elderly over the age of 65 within 3 years in four medical centers. All the elderly could walk independently and did not receive cancer therapy. MRI results of functional areas of the cortex and space-time variables measured by Gaitmat II from the multiple linear regression model have been analyzed that the shortening of step length and the extending of feet support time are related to the decreasing of sensorimotor area and the reducing of the amount of movement, vision and cognitive areas of the parietal bone, and these are independent of other risk factors (peripheral nerve disease, brain structure abnormalities and obesity, etc.) of gait. More results have been concluded that early interventions in cardiovascular drugs and exercise can delay the process of brain structure atrophy for the elderly and the related motor function.

Parkinson's disease (PD) is a common neuromuscular diseases. Movement disorders in particular gait disorders are the main features. Roiz R. M. et al [13] have used 3D motion analysis system to do gait analysis and comparison in 12 patients with congenital PD and 15 healthy human. They have found that compared with healthy people, PD patients have the reduced stride length, the slowed down pace and the limited lower extremity range of motion. The slow walking speed and the reduced stride length have been analyzed in relationship. This is inconsistent with previous studies which have regarded the slow walking speed to be related with the stride frequency. This may be in relevant to the inconsistent disease process.

Gait analysis used in the sports medicine and the sports injury can help to make clear the mechanism of the athletic injury and to prevent and reduce injury. Li Feng et al [14] have analized the plantar pressure distribution of 30 healthy fencers under the normal walking and the lunge using the F-scan system. Under the lunge, the torque force generated by the exessive varus/valgus of the foot at the very moment of the heel against the ground may be one of the reasons leading to the chronic knee injury. And they also proposed the mothod expectedly to prevent knee injury.

With the development of gait analysis, it is playing an increasingly important role in the diagnosis and treatment of cerebral palsy. The analysis results from Li Hai et al [15] in 78 normal children and 25 cases of cerebral palsy children based on the gait plantar pressure analysis system have shown that, compared with normal children, young children with cerebral palsy has smaller step frequency and longer period; the absolute symmetry index (ASI) of the single-foot support time, the swing time, the feet support time and the gait cycle time are all significantly higher than normal children. The research of Bell et al [16] on 8 cases of children with cerebral palsy has also suggested that, without surgical intervention, the walking function of children with cerebral palsy has decreased significantly.

Ankle foot orthotics (AFO) has been often used to improve the gait in hemiplegic patients. It can assess the effectiveness of patients walking by comparing the gait before and after installation of AFO. Nolan [17] has once assessed the effect of AFO in the continuous 10 months on a right side hemiplegia patient after one month of a stroke. The stride length and the walking speed have been increased significantly. The step width and the feet support time have been reduced significantly., And the moving angle of the hip joint in the swing phase has been increased. These illuminate that AFO has increased the stability of the ankle during the walking, and improved the hemiplegic gait. It needs more study in the future on the hemiplegic patients of different ages with AFO.

3. Outlook

Walking gait is the feature for the human behavior. The normal walking involves the coordination and the coorperation of multiple systems. If the lesions occured in the bone, the nerve or the muscle system, it is easy to show in the gait. Therefore, it has very important significance to apply the gait analysis to the clinical diagnosis and the disease assessment of the skeletal, the nervous and the muscular system

With the development of gait analysis, it has developed from the initial visual method for the present three-dimensional analysis way. 3D gait analysis system can objectively and quantitatively

assess the walking function of the human body. The system consists of photovoltaic systems including reflective landmarks, electromyography systems and synchronous video system. The testing accuracy and reliability has been greatly improved compared with the visual observation and the footprints method, and has been appled all over the world. But this system is complicated and requires a strong professional that, for the expensive, yet it has not universally applied in clinic in China. Because of the simple and easy to get unlimited by the equipment, operating and other conditions, the footprints and the visual methods, are still used on clinic in China [7]. Although some units have developed a few gait analysis systems, but standards are not uniform [18-19]. Thus, the domestic clinical needs a simple, sensitive, accurate and more uniform standard gait analysis system. It is sure that, with the rapid technological development, the operating system for gait analysis will be improved toward the direction of more intelligent, portable and accurate. And the gait analysis technology will also become more widespread. If it selected the targeted analysis method based on the patient's specific circumstances and various characteristics, perhaps it could provide more effective help about the clinical individual rehabilitation programs development and the rehabilitation efficacy assessment.

It also can be a useful technique for the scene reconstruction in forensic sciences.

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Fatal Heroin Intoxication in Body Packers: One Case Reports and Review of the Literature

Abstract It has reported a case of death due to the effects of heroin concealed in a man who was attempting to smuggle the drug within his gastro-intestinal track. He successfully escaped from the airport detection and reached the destination-Chongqing from Yunnan province in China. He was sent into the old age assistance service center because of poor health and then died after 12 hours. According to forensic procedure of sudden unnatural death, the decedent had to accept a series of examination such as CT scan, autopsy and toxicological analysis. He was found die of acute heroin intoxication due to the rupture of drug packet in the stomach. This case illustrates the challenges to airport inspectors and forensic medical examiners in evaluation of potential drug packers and therefore it needs to consider all factors involved in forensic diagnosis.

Keywords: Forensic science; Heroin; intoxication; Body Packer; Morphology; Case report;

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Introduction

Body packers are smugglers who conceal narcotic for transport in their bodies. Handmade or automatically produced packets are swallowed, rectally or vaginally inserted, and transported to destination for commercially or own use [1]. The package may be wrapped in cellophane, layers of latex, rubber cots, condoms, plastic bags, aluminum foil, plastic foil, wax sealing, carbon paper or self adhesive tape [2-3].The extent of smuggling by body packers is unknown, and little information exists regarding the fatalities that arise from this practice. However, it is thought that because of increasing sophistication in intracorporeal concealment methods, only a few body packers die of poisoning because of leakage of an internally concealed container [4]. A statistical analysis from China Narcotics Control Report 2011 reveals that Heroin is still one of the most frequently used drugs which is highly potent semi-synthetic opiate, and has been favoured in illicit drug trafficking. While drug packets are inside the stomach and bowels, they can leak or rupture causing acute substance toxicity, bowel obstruction or bowel perforation. The most severe complication of the body packer syndrome is acute fatal intoxication.

Body packers were first reported in Toronto in 1973 [5], but the first autopsy on a narcotic fatality described cerebral and pulmonary congestion in 1852 [6]. Additional signs may include portal adenopathy, track marks, renal nephropathy and leukoncephalopathy. These pathological signs are considered “typical” but “neither certain nor characteristic”, thus in conducting a forensic investigation of death due to narcotism. It is important to consider all factors including decedent history, clinical manifestation, radiological results, pathological changes as well as toxicology findings [7].

It has presented a case of death caused by heroin intoxication in a body packer and retrospectively reviewed some literatures published in recent years so as to highlight the challenges in its forensic diagnosis. We hope that the information heroin will further contribute to forensic medical examiners understanding of the characters of drug packers.

Case report

Case history

A Chinese male came to Chongqing from Yunnan Province in China and stayed in old age assistance service center in Yubei district because of poor health. One day before his death, he told the service center worker that he felt uncomfortable and asked for some medicine. After having the medicine, he went to his room. He was found dead about 12 hours after last being seen by the worker. After a crime scene investigation, the deceased was transferred to department of radiology of the Third Military Medical University for a total body scan and then transported to Department of Forensic Medicine at Chongqing Public Security Bureau for a medico-legal autopsy. The autopsy was performed six hours after the body was found.

CT findings

The decreased was underwent an initial whole-body CT scan (GE Medical Systems, USA) at the Third Military Medical University. No orally or intravenously administered contrast agent was used. The scanning protocol included a collimation of 64×0.625mm, pitch of 0.984:1, rotation speed of 0.5 second, tube voltage of 120kV and tube current of 300mA. Images were retrospectively reconstructed at the CT console to a section thickness of 3.0mm. The CT images were reviewed by two experienced radiologists for the presence, distribution, and pattern of drug packets. In this study, the CT density of the packets was classed as inhomogeneous hyperdense, and homogeneous isodense (-40 ~ 30HU), homogeneous hypodense. Herein referred to a CT value lower than -40HU, which was the value obtained for fat. Methamphetamine referred to a CT value 100HU. CT manifestations of body packing included the presence of shapes, varied density and well-defined round or ovoid intraluminal foreign-body shadows that were closely arranged along the GI tract. For the heroin packets, most of them which were homogeneous isodense were located in the stomach, small intestine and descending colon & sigmoid colon area (Fig.2A-C), while another 3 packets which contained methamphetamine (Fig.2C,F) manifested numerous pellet-shaped inhomogeneous hyperdense in small intestine and sigmoid colon area. For that reason, heroin packets with homogeneous isodense density became more apparent after manipulating the image windowing (Fig.2D-F). The shape was mostly sausage like or round. The virtual distribution of drug packets was reconstructed by volume rendering (VR) (Fig.2G).

Autopsy findings

The deceased was a 55-year-old Chinese male. There were no violent wounds found on the body or injection sites. The brain had outstanding features of increased intracranial pressure including

Fig.1 25 drug packages swallowed orally were hand made. The packets are 2cm in diameter and 3-5cm in length. There were 14 condom balls of white powder in the stomach and one of them (red arrow) was split open at the gastro-oesophageal junction (A). 11 condom balls were found in small intestine and descending colon & sigmoid colon, 3 colon balls (red star) contained red pellets (B).

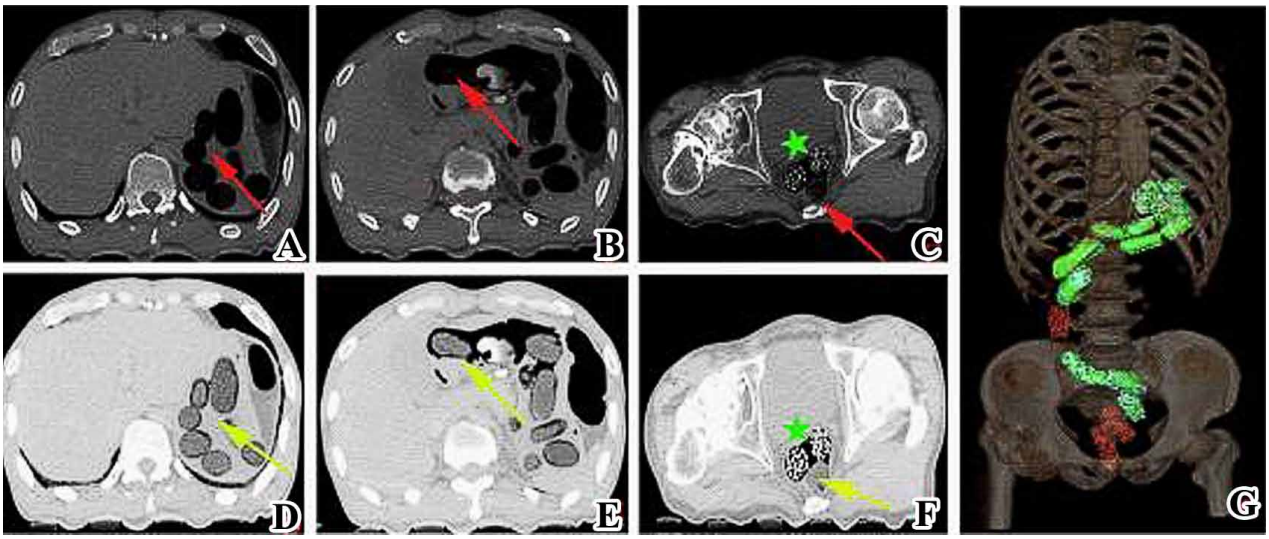

Fig.2 Homegeneous isodense packets on abdominal CT with different CT windowing, some round homogeneous isodense foreign-body shadows (red arrow) in the GI track with standard abdominal windowing (level 40 / width 400) (A-C) were classified as indefinite. After mainpulating the windowing (level-175 / width 600) (D-F), they (yellow arrow) became conspicuous by the round shape and smooth edge that was seen, and were easily differentiated from residual bowel contents. Heroin packets were homogeneous isodense (arrow), but methamphetamine (star) mainifested pellet-shaped inhomogeneous hyperdense (C, F). Drug packets distribution along GI track by VR (G).

flattened gyri, consular herniation and uncal grooving. There was marked congestion of cerebral vessels, but no evidence of intracranial haemorrhage. Pulmonary edema and congestion were observed in both lungs. At autopsy 25 condom balls were retrieved from his body (Fig.1). In the stomach, a turbid solution was seen with some small pieces of plastic and gastric mucosa was markly congested with no ulcerations. There were 13 condom balls of white powder in the stomach and another 1 condoms had been split open at the gastro-oesophageal junction (Fig.1A). There were 2 condom balls containing respectively red pellets and white powder in small intestine. In descending colon & sigmoid colon anther 2 intact condom balls of red pellets and 7 balls of white powder were found (Fig.1B). The pattern of packing was such that the powder (pellets) was wrapped inside a white rectangle plastic sheet. It was not tied, but only twisted on the surface by string. Each package was then put into a condom. The ball was enclosed by a knot tied at the end of the condom. All

of the drug packets were produced manually. The maximal package was 2cm in diameter and 5cm in length and the minimal was 2cm in diameter and 3cm in length. The commonest sizes of the packets were approximately 4*2*2cm.

Toxicological analysis

Urine, blood and gastric contents were collected and sent to the toxicology laboratory in the department of forensic medicine. Using thin layer chromatography, heroin and 6-momoacetylmorphine (6-MAM) were identified in the gastric content along with white powder. In the blood, 6-MAM, morphine and codeine were detected using the thin layer chromatography technique. The serum levels of 6-MAM measured by LC-MS/MS (AB Company, USA) were 29.786μg/ml. Morphine, 6-MAM and codeine also were identified in the urine using thin layer chromatography and by LC-MS/MS.

The intact powder (pellets) packets were submitted to the police department and then sent to the government laboratory for measurement of its purity. The report revealed that the heroin powder was 210g with purity of 59.9%, and red pellets contained methamphetamine with weights and purity of 55g and 13.3%.

The cause of death in the victim was a heroin overdose and the estimated quantity of heroin that leaked into his stomach was 4g.

Discussion

Concealment and transit of heroin is a major business worldwide. During the last decade, increased rates of drug trafficking have resulted in more creative methods being adopted by smugglers. One of these methods of illicit drug smuggling is body packing. However, The detection of these packets is not only a challenge to customs officials and police interested in preventing the importation and trafficking of illegal drugs but also to physicians and forensic medical examiners responsible for identifying and managing drug packers [8-10]. Therefore, it is very important that how to recognize potential body packers including how to interpret radiological appearance of possible body packers, of patients with symptoms of intoxication, and of people coming from abroad with signs of an ileus.

Heroin is a chemical product of opium which is refined out of the milky juice of the poppy capsule. Usually, the heroin powder has a bright or white color, but depending on the admixture of substances, color and consistency may vary [11]. Heroin is well absorbed from the gastrointestinal track. Tolerance develops rapidly, but there is marked individual variation in sensitivity to the dug. Consequently the acute lethal dose varies between individual and within individuals depending upon their previous exposure to opiates. Symptoms and signs of opiate toxicity include nausea, vomiting, constipation, depression of consciousness, respiratory depression, coma and death. The decedent died of the effects of acute heroin toxicity that could not be medically reversed. This occurred immediately leading to irreversible pathophysiological changes that caused coma and resulted in death. The minimum lethal blood level of heroin is at 0.2mg/L [12-13]. Opiate absorption occurs mostly in the gastrointestinal track to reach peak plasma level after 30-90minutes [6]. Tissue re-distribution of heroin and its metabolites is very rapid [12,15]. Once the conversion of heroin to morphine is completed, the measurable detection of the morphine is limited to 12 hours [12,14-15]. Thus even with the most sensitive methods the maximum limit of detection does not exceed 48 hours in plasma [14-15].

The main findings at autopsy were pulmonary edema, congestion of the cerebral vessels, hyperemic gastric and colonic mucosa, and epicardial haemorrhage. These are consistent with pathological finding from similar cases reported of narcotic fatalities [6,16-19]. The mechanism of death is usually related to respiratory failure secondary to the direct suppressor effects of the opiate metabolities on respiratory centers leading to hypoxia, hypercapnia and pulmonary edema. The actual pathophysiology of pulmonary edema is unclear, but is thought to arise as a direct result of hypoxia, capillary permeability and fluid extravasations into the alveoli [6, 20-21]. Epicardial haemorrhage as documented in this case result as a sequel of pulmonary edema as well as injury caused directly by hypoxia and heroin toxicity to the coronary capillaries. No specimens were taken for histology, because we did not foresee any additional value from histology in this particular case having been limited by constraints previously explained elsewhere [20].

The size and form of foreign bodies depend on the way drug-filled packets have been produced and how they have been inserted into the body. Commonly, Drug packets are hand made or mechanically produced. Generally, there are two or three layers used as wrappings, but eight different layers were found in one case of a surviving person [16]. Condoms, latex, cellophane, and other synthetic materials are formed to balls or oval-shaped objects usually 2-4cm in size. The swallowed packets (2cm in size, spherical in shape) are smaller than the rectally or vaginally inserted drug packets

(4-6cm long and 2-3cm wide, oval form) [11], a ball-like form of packets inserted into the rectum with a diameter of 5.5cm and a length of 8cm is not rare [22]. Mechanically produced packets have a uniform shape, mostly round and 2cm in diameter, whereas handmade ones each look a little bit different each. Yang et al. [22] reported 124 cases of heroin body packets which were produced mechanically. In our study all drug packets are hand made, so the size of each packet is different.

Drug packages in the body can result in mechanical complications such as gastro-intestine obstruction, perforation and consequent peritonitis [11]. Obstruction has been described at the gastro-oesophageal junction, pylorus, ileo-caecal valve and colonic flexures. Package rupture can result in systemic drug absorption and cause drug toxicity and overdose [8]. There are some factors that cause package rupture or leakage, firstly most of materials wrapping drugs are vulnerable to gastric acid; secondly the packages are easily damaged by mechanical movement especially in vomiting; thirdly fluid from the GI tract may permeate the walls of the packet and result in rupture; fourthly the constipating effect of heroin will lengthen bowel transit time contributing to rupture of packets; finally laxatives and paraffin oil may favor packet rupture and drug intoxication [23-24]. However, the relationship between the rupture of drug packets and the factors above mentioned is still further explored.

The history provided by potential drug traffickers is often unreliable, so radiographic imaging play an essential role in identifying body packers and monitoring packet evacuation. To date, Plain X-ray film, Ultrasound, CT and MRI are the most commonly used methods to examine people suspected of being body packers.

Plain X-ray of the abdomen(AXR) in an upright and supine position is the most commonly used radiological examination to detect drug-filled packets, and is considered to be the gold standard screening tool [1, 8, 11, 25-26]. The sensitivity of AXR to detect drug packets has been shown to be around 85-93.5% in the literature [22, 26]. False negatives may arise due to difficulties delineating the packet margins from residual bowel contents [22]. A few papers report on the typical appearance of the different drug depending on their density [27-29] that hashish is described to appear on the X-ray film as a very dense substance in comparison with stool; both are denser than water. Cocaine should have an attenuation lesser than water, whereas heroin should look like air. However, the density of these drugs may vary depending on their composition, the degree of purity and the materials & techniques used in packaging [11, 30-31]. The most common radiographic findings in the body packers are spherical or cylindrically shaped densities throughout the abdomen, sometimes surrounded by thin rims of air or clearly outlined by dense wrapping material. Occasionally, they are arranged in parallel within the bowel lumen [22].

Computed tomography is the most sensitive method for detecting ingested drug packages. It should be used when an AXR is negative, but drug packing is still strongly suspected [8, 11, 22, 30]. Unenhanced CT has been shown to be a fast, accurate and easily reproducible imaging modality for the detection of ingested drug filled packets. Sensitivity is generally excellent, ranging from 95.6-100% [22, 32]. At the same time, CT is also useful for the identification of any associated complications like intestinal obstruction and perforation [26]. There is a report [28] about using CT measurement of drug packets in the bowel that hashish has a density like bone, cocaine is less dense than fat, and the Hounsfield units of heroin are situated between fat and air. Identifying the homogeneous isodense heroin packets is really a tough problem. The homogeneous isodense packets in the GI tract may go undected if the window width and level settings typically employed for abdominal CT (window width 400HU, window level 40HU) are used. We therefore recommend, in cases of suspected homogeneous isodense drug packet ingestion, manipulating the windowing (level -150 ~ -300/width 600 ~ 800) in addition to those commonly used for abdominal CT. in our study, some heroin packets with homogeneous isodense became apparent on manipulation of image windowing.

Magnetic resonance imaging does not have any diagnostic value for the detection of drug packets in the bowel because there are no free protons and the packets are tight against water, packets should appear as geometrically formed bodies without any signal in a fluid-filled bowel provided the bowel has been immobilized with spasmolytics. The MRI is diagnostically useless in an air-filled bowel with normal peristalsis [11].

Conclusion

It has recommended a protocol for the identification of body packers.

1. A detailed initial history focuses on ascertaining the type of drug, the number of packets ingested should be obtained from drug

packers or their attendants.

2. Clinical manifestations induced by drug packets inside their bodies.

3. Toxicological analysis as fast as possible in decedent being suspicious of drug packers.

4. Plain X-ray of the abdomen (AXR) is initial recommendable method; CT should be used when an AXR is negative, but CT is the first-choice tool in cases of sudden unnatural death.

5. Autopsy is essential for the decedent to ascertaining a potential body packer.

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Validated Throw Distance Method by Surveillance Video

Abstract Vehicle-pedestrian collision is one of the most frequent and most severe types of road accidents. The impact velocity is the most important factor in vehicle-pedestrian accident reconstruction, and it can be calculated by many theoretical or empirical methods including throw distance. The throw distance method needs to be validated by other methods for more credible. In this paper, a traffic accident was caught by surveillance video, and was employed to validate the throw distance method provided by *The Speed Technical Evaluation for Vehicles Involved in Representative Road Accidents* (GA/T 643-2006, China, 2006).The results showed that the impact velocity was calculated by throw distance (36.39 km/h) which is 22.01% lower than the video monitoring (46.66 km/h), which indicated that the vehicle speed calculated by throw distance was much lower than the real-world speed. Further studies are needed to modify the throw distance method by more evidences.

Keywords: Accident reconstruction; Vehicle–pedestrian accident; Vehicle speed; Throw distance; Surveillance video;

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1. Introduction

At present, the road traffic accident has become one of the most serious social hazards which the whole world faces together. Nearly 3,500 people die on the world's roads every day. Tens of millions of people are injured or disabled every year. Children, pedestrians, cyclists and the elderly are among the most vulnerable of road users [1]. China has consistently ranked as the country with high percentage of pedestrian fatality rates because of its mixed traffic and transportation ways [2]. According to the Road Traffic Accident Annual Census Report of China [3], more than 81,649 persons died in at least 327,209 accident cases in 2007, among which the pedestrian accounted for 25.85%, being the highest proportion of all traffic fatalities.

In vehicle–pedestrian accident reconstruction, the two most important objectives are to determine the impact position and the impact speed. The vehicle impact speed is the prior focus for accident investigators [2]. The impact speed can be calculated by many theoretical or empirical methods which have been used to calculate the impact speed and can be categorized by evidences required. The categories are the post-braking-distance [4], the throw distance [5–7], the vehicle damage [8–9] and the pedestrian injury [10–11]. Here, the throw distance represents as a method to calculate the impact speed according to the throw distance, and the throw distance methods has been employed in *The speed technical evaluation for vehicles involved in representative road accidents* in 2006.

The video surveillance system as an important safe surveillance in traffic and police has been widely used in security and other fields for its full and accurate information. Along with more surveillance cameras using, more traffic accidents have been caught. Cameras can record not only the process of a case, but also the details of a traffic accident, such as vehicles routes, vehicles speeds, pedestrian projection distances and so on that these pieces of information are based for appraising a traffic accident.

Throw distance methods are usually obtained by two ways that one by statistical analyzing the real traffic accidents data [7] and the other by computer simulation like the PC-Crash [12] or the Madymo pedestrian model [13]. Compared with the computer simulation, real traffic accidents data is more credible but has its confidence interval; the PC-Crash's pedestrians is a multi-rigid-body system only for simulation, so it is different from real traffic accidents and the results need to be validated by plentiful real cases. When a traffic accident is recorded by the video surveillance system, it could calculate vehicles speeds and the speeds would be exacted.

Sometimes, in order to make the vehicles speeds more credible, solutions of these methods are often used to validate each other. In this paper, it used a clear video from a traffic accident case, which was provided by *the State Key Laboratory of Vehicle NVH and Safety Technology (Chongqing, China)*. This case was a vehicle–pedestrian collision, in which it has calculated vehicles speeds by throw distance method and by the surveillance video. The purpose of this study was to validate throw distance method by the surveillance video.

2. Methods

2.1. A case study

A vehicle–pedestrian collision occurred on a flat road on sunny day, on October 17, 2011, in Chongqing. The process of the traffic accident could be observed clearly by video. Before the case, the suspected vehicle wanted to overtake another car, while at the

a b c

Fig.1 The traffic accident scenes.
(a, b, c: the positions of the white car at scenes)

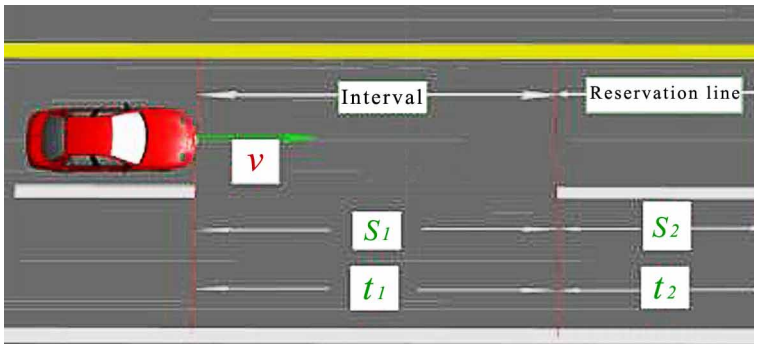

Fig. 2 A sketch for the vehicle speed calculating.

a b

Fig.3 The impact position and the rest position of pedestrian.

same time, a pedestrian was standing at the middle of the road. The driver braked at once, but the car still impacted the pedestrian. The pedestrian flied, landed and slid to the rest position, and the car braked until stopped.

2.2. Surveillance video

The video surveillance system can clearly record the pedestrian–vehicle accident information. According to $v = \Delta s / \Delta t$ (where v is the speed, Δs is the distance, and Δt is the time.), the movement of objects at average speed was the displacement in a unit time. In dynamic image sequences, Δt may be calculated directly by the export of the frame rate. It can analyze the video frame by frame for choosing reference distance, determining the time of vehicles through the reference, measuring the driving distance of vehicles in this time, and calculating the vehicles speeds finally. The points from the surveillance video method are accurate reference distances and the number of frames.

In this accident, the white car positions were various in different scenes (Fig.1)

In video, car positions are corresponding with the time. A reservation line was employed as the mark. The car was driven pass a reservation line and an interval in this pedestrian–vehicle accident (Fig.2). The interval was the "a-b" phase, the reservation line was the "b-c" phase, and s_1, s_2, t_1 and t_2 were the distances and the driving times for the reservation line and for the interval, respectively.

It assumed the car was decelerated uniformly with a frictional drag coefficient a on a dry and flat road. According to Newton's laws, the car speed can be calculated by Eqs. (1), (2) and (3)

$$v_a = v_b + at_1 = v_c + a(t_1 + t_2) \quad (1)$$

$$v_a^2 - v_b^2 = 2as_1 \quad (2)$$

$$v_b^2 - v_c^2 = 2as_2 \quad (3)$$

Where v_a, v_b and v_c are the car speeds (m/s) respectively at points of *a*, *b* and *c*. In this phase, the car speed can be calculated at every frame.

2.3. Throw distance

The throw distance was defined from the impact position to the rest position of pedestrian. The impact position and the rest position of pedestrian were in scenes (Fig.3).

The surveillance video recorded all details for a traffic accident. It could calculate the speed and the time of the vehicle and the throw distance of the pedestrian. The impact speed of the vehicle can be calculated using Eq.(4)

$$v = \sqrt{2g} \times \varphi \times \left(\sqrt{h + \frac{S_p}{\varphi}} - \sqrt{h} \right) \quad (4)$$

Where v is the impact speed (m/s) of vehicle, the sliding adhesion coefficient; the throw distance (m), h the height of the gravity center of the pedestrian (m) and m/s^2.

The height of the pedestrian's gravity center can be calculated by Eq.(5).

$$S_p = 5H / 9 \quad (5)$$

Where H is the height (m) of the pedestrian.

When the throw distance and the height of the pedestrian were obtained, the vehicle impact speed could be calculated by Eqs. (4) and (5).

3. Results

3.1. Calculating the vehicle speed by the surveillance video

In this case, a reservation line was employed as the mark. The frequency of the surveillance camera was 25 frames per second. The distance of reservation line length (s_1) was 6.0 m and respectively the interval (s_2) was 9.0 m; The car driven pass the reservation line and the interval, which respectively consumed 14 and 11 frames. So, the distances and the driving times of the reservation line (t_1) and the interval (t_2) were 0.56 s and 0.44 s, respectively. According to Eqs. (1),

(2) and (3), the car speed and the decelerated rate can be calculated as

v_a=17.44m/s=62.78km/h (6)

v_b=14.71m/s=52.96km/h (7)

v_c=12.57m/s=45.25km/h (8)

a=4.87m/s2 (9)

v_a, v_b and v_c were all not the impact speed of car (v). The impact point was 2 fremes (t=0.08 s) before the point c. The uniformly decelerated rate of the car was 4.87 m/s2. The impact speed can be calculated as

$v = v_c + at$

= (12.57 +4.87*0.08) m/s = 12.96 m/s = 46.66 km/h (10)

3.2. Calculating the vehicle speed by the throw distance

In this case, the pedestrian was a 56 years old female with the height of 1.50 m. The height of the pedestrian's gravity center (h) could be calculated by Eq. (5)

h = 0.8333m (11)

Because the impact point was 2 frames before the point c that the distance (x) between the impact point and the point c could be calculated by Eq. (12)

$v^2 - v_c^2 = 2ax$ (12)

According to Eq. (12),

x = 1.02m (13)

another part of the throw distance of the pedestrian was 15m. So,

S_p = 1.02 m+15 m=16.02 m (14)

According to *The Speed Technical Evaluation for Vehicles Involved in Representative Road Accidents* (GA/T 643-2006, China, 2006), the friction coefficient (φ) between the woman pedestrian and the dry flat road was 0.44, that the car speed (v) could be obtained via Eqs. (4), (11) and (14) as

v = 10.11 m/s = 36.39 km/h (15)

3.3. The relationship between the throw distance and the surveillance video

The results showed that the speed of the car was calculated 22.01% lower by the throw distance (36.39km/h) than by the surveillance video (46.66km/h).

In the previous demonstration, Fugger 2000 represented the solution of Fugger's method [14], which was

$v = 8.364 * S_p^{0.6046}$ (16)

Where v was the vehicle impact speed (km/h).

Toor 2003 represented the solution of Toor's method [15], which was

$v = 9.84 * S_p^{0.57}$ (17)

The car speed (v) could be obtained via Eqs. (14) and (16) as v=44.75 km/h; and via Eqs. (14) and (17) as v=47.82 km/h. The impact velocity calculated by Fugger's method was lower (1.91 km/h) and higher (1.16 km/h) by Toor's method than by the monitoring video. Compared with the throw distance, Fugger's and Toor's results were closer to the surveillance video, with a spread averaging about ± 4.1%.

4. Discussions

In this study, it has provided the evidence that the vehicle speed calculated by the throw distance is much lower than the real speed. The impact velocity calculated by the throw distance (36.39km/h) is 10.27 km/h lower than by the surveillance video (46.66km/h) in this case.

The results are consistent with the previous reports. The current study has shown that the pedestrian pre-impact posture and velocity has a significant influence on pedestrian kinematics during vehicle-to-pedestrian impacts. Many models, both theoretical and empirical, have been developed over the last 30 years to reconstruct this type of impact, but not all of them yield accurate results, with a spread averaging about ± 10 km/h [16].

Additionally, the case has been employed validating Fugger's and Toor's methods which also based on the throw distance and whose results are closer to the surveillance video than the throw distance method provided by *The speed technical evaluation for vehicles involved in representative road accidents* in 2006. In other words, Fugger's and Toor's methods have higher accurateness.

5. Conclusions

Vehicles speeds are the most important parts of the vehicle-pedestrian accidents reconstruction. The method now more commonly used to determine vehicle speed involves the pedestrian projection distance, while the more traditional method by tyre brake marks is losing applicability because of the population of ABS braking systems on the road. From this study, a traffic accident has been caught by the surveillance video, and been employed to validate the throw distance methods provided by *The Speed Technical Evaluation for Vehicles Involved in Representative Road Accidents* (GA/T 643-2006, China,

2006). The results have shown that the impact velocity calculated by the throw distance is much lower than the real-world speed.

In this paper, there is only one traffic accident. It is not sufficient for identifying the speed of vehicle for not accurately calculated by the throw distance method. But it really is a proof and complication of the precious researches which should be helpful for modifying the throw distance method in future.

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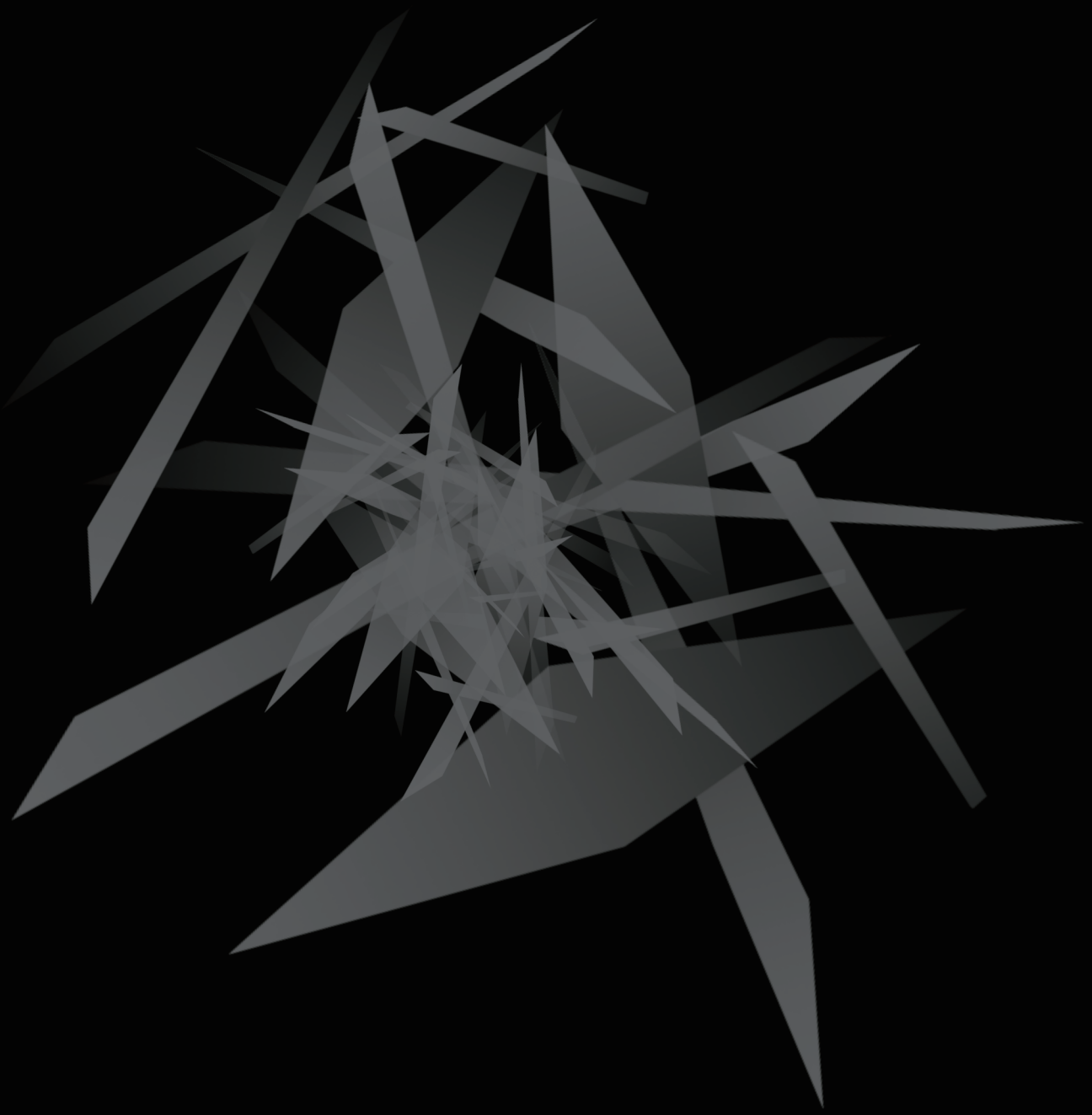

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