APPLICATION OF COMPUTED TOMOGRAPHY IN HUMAN BODY INJURIES

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ABSTRACT

Computed thomography (CT) was, foregoing, used in medical application mainly as a method for diagnostic evaluation to retrench health condition of certain tissue. Assumption of higher leverage of CT images was generate recently, mainly in healing of patients in the way that CT data were used as a database for computational visualisation and production of models and medical apparatus. One of application of CT scanned data is for determination of tissue destruction dimension, what is of high interest during the consideration of characteristics and mechanism of appearance of a gunshot wound. Database of geometric features of gunshot wounds could be obtain with systematic acquisition of data concerning these wounds and will be useful in forensic treatments.
Testing results of gunshot wounds conducted on alternative gelatines blocks were not indicated as a reliable and applicable, and therefore animal tissue was used in our testing. Destruction volume tissue was measured in certain CT sections experimentally.

1 EVALUATION OF TISSUE CONDITION WITH CT IMAGING

CT was discovered by a Sir Godfrey Hounsfield and Dr. Alan Cormack, and for the first time were installed before about 30 years. It has become a mainstay for diagnosing medical diseases. Its advances based on computer technology, CT scanners have improved patient comfort. Nowadays they are much faster and have also possibility to produce higher-resolution images, which improve the diagnostic capabilities of the test. For example, the CT scan can show radiologists tissue injuries, which they cannot see on an x-ray. CT scans are special x-ray tests that produce cross-sectional images of the tissue using x-rays and a computer. These images allow the radiologist to look at the inside of the human without slicing it mechanically. This type of special x-ray, in a sense, takes "pictures" of slices of the body so doctors can look right at the area of interest.

CT and MRI are similar to each other, but provide a different view of the body than an x-ray does. CT and MRI produce cross-sectional images that appear to open the body up. MRI uses a magnetic field and radio waves to produce images, while CT uses x-rays to produce images. Plain x-rays are an inexpensive, quick exam and are accurate at diagnosing things such as pneumonia, arthritis, and fractures. CT and MRI better evaluate soft tissues such as the brain, liver, and abdominal organs, as well as look for subtle abnormalities that may not be apparent on regular x-rays.
CT scans retrench to further look at an abnormality seen on another test such as an x-ray or an ultrasound. The people also have a CT to check for specific symptoms such as pain or dizziness. People with cancer may have a CT to look for the spread of disease.

Penetrating injury into human body can be the result of ballistic trauma from direct missile impact or from missiles that have entered the temporal bone from a different location such as the face or neck. Penetrating injury may also be the result of non ballistic trauma, this can be patient inflicted as a result in rupture of the tympanic membrane, ossicular disruption or even injury to the footplate of the stapes with sensorineural hearing loss.

• CT scanners are found not only in hospital x-ray departments, but also in outpatient offices. CT scanners allows doctors to see diseases that, in the past, could often only be found at surgery or at autopsy.

1.1 Application of CT in terminal ballistics

As a starting point in application of CT in forensic researches of gunshot wounds we have chosen the experiment of shooting in gelatine blocks the material widely used to repleace a living tissue. The way of block production and physical characteristics are described in literature. On this very occasion the gelatine was produced in the factory “Kemika”. The blocks were made with dimension of 470 x 220 x 200 mm. They shot at the block from the distance of 8,5 mm. They used the automatic Russian rifle AK – 74 (kalašnjikov) and bullets cal 5,45 PSGS. The rifle and the used bullets made it possible to achieve the velocity of 900 m/s. To visualise the gelatine block the CT method was used a few hours after shooting. The scanner Hitachi W 450 was used. The samples of shooting are 10 mm (thickness of layer). 45 shootings have been made providing a great number of informations to be processed.

1.2 Application of CT in forensics

The use of CT in Forensic Post-Mortem Diagnostic started about fifteen years ago. Many cases, for example gun shot injuries, head injuries, detection of forgein bodies as well as gas embolism have been published in this time.
The first comprehensive studies of comparison between autopsy and Post-Mortem CT where made in 1994 by Donchin et al. The last comprehensive study was published by Jachau et al.(2004)The CT images provide information about the general pathology of the body and can generate detailed information about trauma injuries Virtual autopsy

combines computed tomography (CT) and magnetic resonance (MR) imaging.. MR imaging is used to focus on specific areas of the body, providing details about soft tissue, muscles and organs. To determine the time of death, Virtopsy uses MR spectroscopy — a technique that measures metabolites in the brain emerging during post-mortem decomposition.

The use of computed tomography in forensic pathology is an increasingly popular diagnostic tool. It is a bloodless and quick examination method, can be used as a storage technology, is independent of investigator and should abbreviate autopsy time. The data makes 2 and 3 dimensional reconstruction possible even a long time after autopsy.

Since the beginning of computed tomography corpses have been examined to develop optimised scan protocols for patients.

A known problem also in clinical imaging diagnostic is to recognize where the limit of regular and the beginning of pathological findings is. A second and important problem in Post Mortem CT is to describe time depending changes.

The aim of the project is to detect, how PMCT can support Forensic Post-Mortem

2 THE MECHANISM OF THE APPEARANCE OF GUNSHOT WOUND

The study of statistic data from police records dealing with the use of fire arms in criminal acts which have been more often used with more dangerous consequences. Undoubtedly the forensics experts show more interest in the study of all aspects of destruction of tissue caused by the bullet shot from firearm. The attempts are made to find out new methods which will help to consider all parameters for obtaining the characteristics of the mechanism of appearance of a gunshot wound. At the same time we have tried to promote the application of highly developed methods from other scientific fields applied to the forensic treatments.

Ballistics, the science of motion and behaviour of bullet shot from a firearm, naturally appeared after the invention of firearms. Later the scope of interest is widened to interaction of bullets and the target. Since ballistics has different fields of study it is usually subdivided into interior, exterior and terminal ballistics. Interior ballistics covers the study of originally accelerating the projectile, for example, the passage of a bullet through the barrel of a rifle. Exterior ballistics studies the passage of projectile through the air. Terminal ballistics studies the interaction of projectile with its target irrespective of being it flesh, metal, wood or something else. The expansion of criminal acts with elements of vandalism and the use of firearms has led to wide development of terminal ballistics. The mechanism of the appearance of wounds has been studied for a long time. It has been cleared that a few factors cause the type of destruction which projectile will make in a tissue of a target:

- shape and construction of projectile,
- turning of projectile in tissue,
- deformation and fragmentation of projectile,

- characteristics of the shot tissue (elasticity and density).

Medical and forensical experience in the treatment of gunshot wounds is numerous. They have brought us to basic knowledge of the geometry of gunshot wound in a tissue. It can be seen in fig 1.

Two different mechanisms of destruction of the tissue can be seen on the figure 1 caused by bullet penetration: mechanical destruction and expanding of tissue causing the permanent cavity and the transfer of energy from projectile to the tissue making a temporary cavity in the tissue. Fruitful development of CT has speeded up the interest for its application in understanding the mechanism of gunshot wounds.

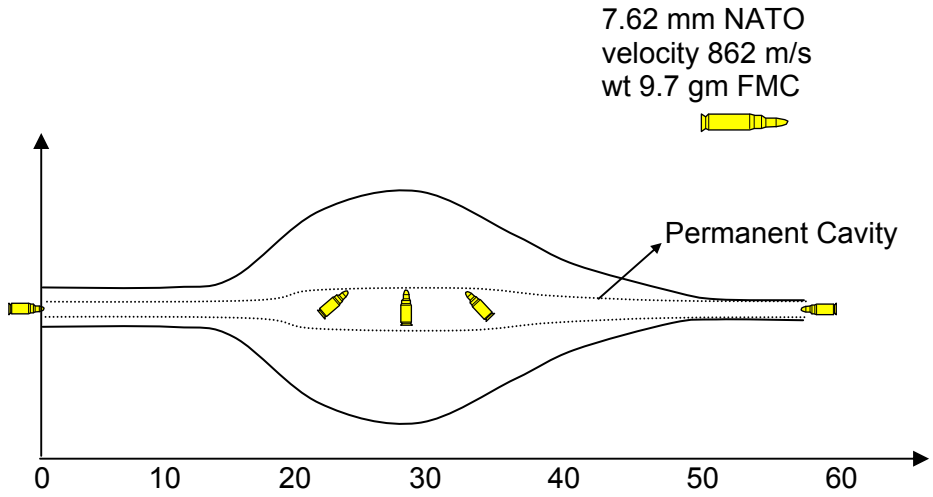

Figure 1. The cross-section of wound profile.

2.1. Preliminary experimentation with gelatine blocks

A lot of data have influence on digital processing of CT shootings during which the images are adapted to request of further numerical processing. Simply speaking two-dimensional CT shooting is divided into columns and lines into squares. Each square is an element of a picture (PIXEL – acronym of “picture element”). The hole in a gelatine block is recognisable as a black element of the picture and the white elements are not damaged.

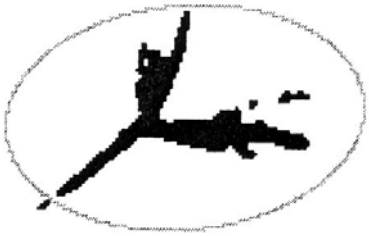

Figure 2. Contour of cross-section of cavity with ellipse

Adjusted computer program is designed to get geometrical characteristics (out of digital picture) of permanent cavity:

- the area of permanent cavity,
- the volume of permanent cavity,
- gravity area (spatial focus),
- the angle of cavity.

The experiment was made on 20 gelatine blocks. No fragmentation or deformation of bullets has been reported. All bullets have penetrated and get out of blocks. It has been noticed that there are two unstable paths: firstly, bullet doesn't move in a line, it can move in various directions. Secondly, the angle between the axis of projectile and the line of path changes from 5 to 90 (tumbling of a bullet). After the experiments the following conclusion can be drawn:

- the big amount of destruction of gelatine appears the bullet has penetrated 100 mm through the block,
- the biggest deformations (destructions) have been observed after 170 – 250 mm,
- after 320 mm the destructions became smaller.

2.2. Experiments on animal (pig) tissue

Experimentation was done also on pig limbs. Total number of limbs that were evaluated was 8. CT scanning was done within 3 hours after the limbs were prepared and wounds were made.

Gunshot wounds were made using automatic gun calibre 5.45 mm, and shouting was done from distance of 10 m . CT Images were exported each 2 mm.

Figure 3. CT image of pig limb after shooting

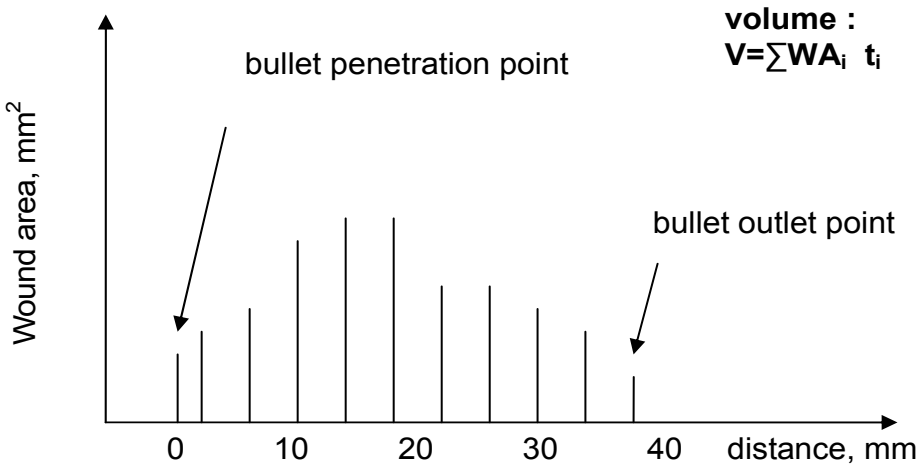

Figure 4. Calculation of destroyed volume of tissue

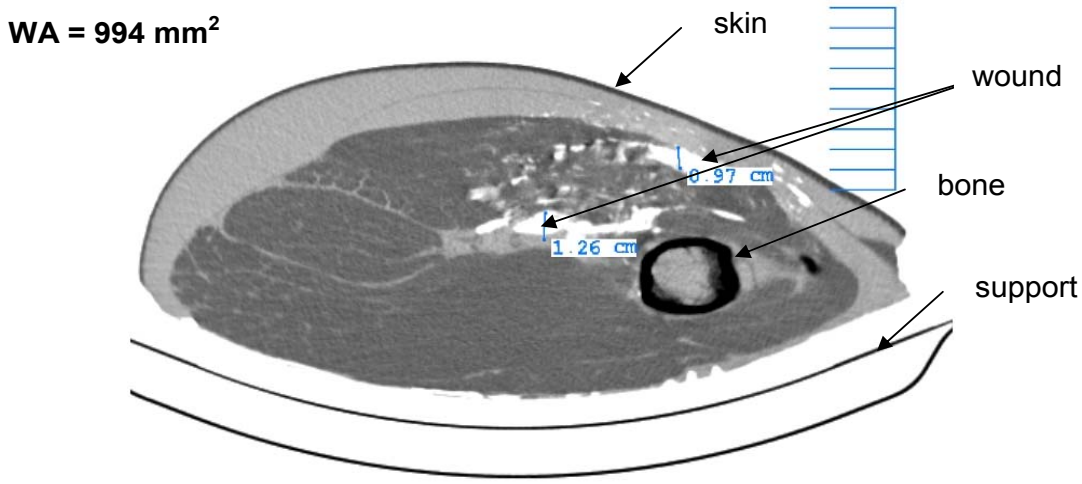

Figure 5. CT image of wound and WA value

3 CONCLUSION

Experiments have confirmed wide possibilities of CT application in terminal ballistics and forensics. Our aim is to get useful information about geometrically relevant characteristics of gunshot wounds. Although the tissue simulants have been widely used there have been attempts to use pigs limbs because it is considered that elasticity of the "real" tissue is more appropriate than the simulant. Our intention is clear to use the spiral CT supplied with mighty software, which enables us to get the three-dimensional figure of wound channel. It is believed that the results achieved by experiments will help us to organise the database dealing with geometrical wound channel of different types of firearms and bullets and that should be of greater use in criminal investigations.

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