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# THE APPLICATION OF COMPUTER TOMOGRAPHY IN THE DIAGNOSIS OF PENETRATING GUNSHOT WOUNDS CAUSED BY NON-LETHAL WEAPONS

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Summary

Non-lethal weapons are originally meant to overpower a man for a short time, not causing any injuries of the body or any other health hazards. Thus, the bullets used in non-lethal weapons are described as non-penetrating. Yet, practice shows that the above assumptions are not always fulfilled and there are cases of gunshot wounds caused by non-lethal weapons when bullets or their parts penetrated the body. The authors of this report conducted experimental computer tomography (CT) examination of rubber and plastic bullets used in non-lethal weapons. Those bullets were attached to the surface of the abdominal cavity of the examined person. The results of the experimental examination proved that CT is, to some extend, an effective method of diagnosing gunshot wounds caused by non-lethal weapons with rubber bullets. Yet, to make those bullets evident in CT examination the parameters of the examination need to be corrected. The application of CT examination does not lead to the demonstration of little plastic bullets.

## Introduction

To conduct the examination in the above work the CT radiological scan technique has been used. Such technique is based on the use of electromagnetic radiation emitted by short waves of high frequency X-radiation. The reduction of X-rays penetrating the human body is closely related to the wave length, the real atomic number of tissue constituents, density of the examined structure and the thickness of the examined object. The differences in the reduction of radiation after penetrating the body are reflected on the X-ray film, which in turn allows to differentiate tissues as well as foreign bodies. Contrary to classic X-ray examination, in CT examination the beam of X-rays, thanks to the rotation of the lamp, goes through examined layers at different angles, and the final picture in recorded in digital form. Owning to the digital recording of the data the distribution of shaded and

clear places visible in CT examination can be processed and transformed. There are two parameters usually used to process the CT picture: the window level and the window width [1; 2]. Depending on the aim of the examination those values can be altered so as to demonstrate the anatomical structures examined, air or foreign bodies. The general rules of CT operation described above lead to the assumption that rubber and plastic bullets might be visible in such examination.

## Aim

The aim of this work is to decide whether it is possible to prove the presence of penetrating gunshot wounds caused by non-lethal weapons by applying standard CT examination reports, with no data about the possibility of such wounds available from case history.

## Materials and methodology

In the examination bullets from the following non-lethal weapons have been used: 'Chrząszcz' (cylindrical rubber bullet 18.8mm in diameter), 'Bąk' (a single bullet 17mm in diameter), 'Rój' (15 rubber balls, each 8mm in diameter) and a plastic element – a concentrator from the 'Rój' bullet as well as plastic gun bullets 9 mm in diameter. Additionally, a shot bullet from a revolver cal. 38SPL, containing tiny leaden shot, has been used.


**Fig. 1.** Types of the ammunition used in the examination

The bullets have been attached to the surface of abdominal cavity of the examined person and the CT examination has been conducted. To stress the difference between the characteristics of a radiological picture of non-lethal weapons and ball cartridges also the metallic ball cartridges have been attached to the examined person.

Methodology and parameters of the examination:

• the examination of abdominal cavity has been conducted with the CT SOMATOM+Siemens set; rubber and plastic bullets, ball cartridges and a plastic concentrator have been placed on the surface of the body and standard radiation exposure for abdominal cavity has been applied (120 kV, 240 mA), with the spiral technique; the layer thickness was *pitch*, and the remote control scan had parameters of W350, L50.

## Results

CT examination of the abdominal cavity demonstrated rubber bullets and a plastic concentrator on the remote control scan, with parameters of the window W350 L50, at the same time not showing them in crosswise scans with parameters W300 L40.


**Fig. 2.** The remote control scan with visible rubber bullets and a plastic concentrator

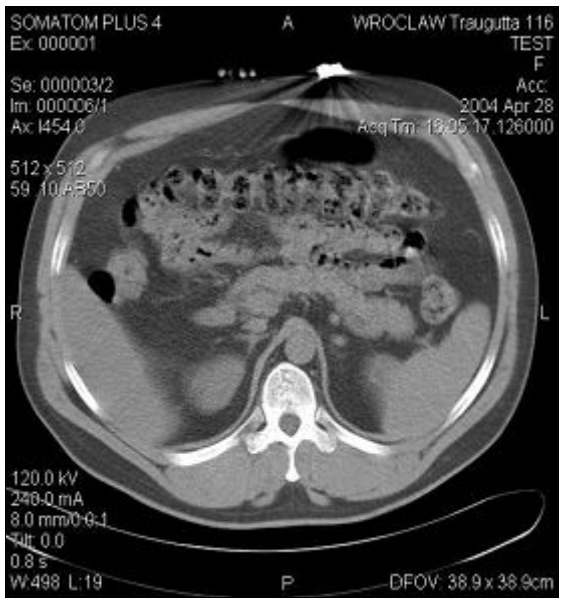


**Fig. 3.** Crosswise scan of the abdominal cavity with a visible metallic bullet, without the rubber and plastic bullets being noticeable

The alteration of the above parameters led to the demonstration of rubber bullets and the concentrator in crosswise scans. The coefficient of radiation reduction for those bullets is within the range of 78 jH to 90 jH. Despite the alteration of the parameters the plastic bullets have not become noticeable.

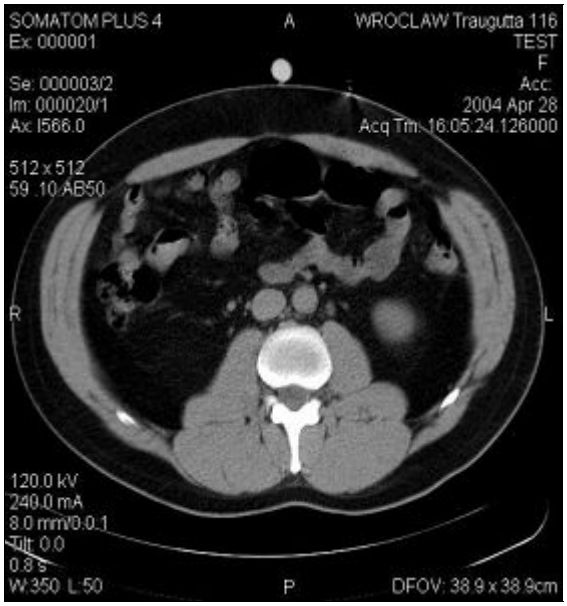


**Fig. 4.** Crosswise scan of the abdominal cavity after the alteration of parameters, with a rubber bullet visible, without plastic bullets being evident

## Description

Gunshot wounds caused by non-lethal weapons are not very frequent; moreover, as they usually happen during times of riots, the victims often tend to hide the fact that they have been injured [3]. Consequently, doctors conducting the examination may not have any information about the possibility of the existence of such wounds and thus may not be aware of the need to search for non-metallic foreign bodies. Such assumption has been adopted by the authors of this work, who tried to use standard parameters for the examination. Although in the CT examination of abdominal cavity, with the application of standard parameters, the rubber bullets were visible only in the remote control scan, it is believed that this type of examination might be useful in examining cases similar to those discussed here. The picture from the remote control scan with evident foreign bodies oblige radiologists to change the parameters of the window and to search for foreign bodies in crosswise scans, as the bodies are not being noticeable while applying standard parameters. Unfortunately, even the alteration of the examination parameters does not lead to the demonstration of plastic bullets. In comparison with ball cartridges, which do not have to be searched for in the pictures as they are clearly visible, rubber bullets are much less visible and plastic ones are completely invisible. The radiation reduction coefficient of rubber bullets is considerably lower that the coefficient for ball cartridges. Thus, one has to be very careful and accurate to notice and describe such bullets, especially when there are no data about the possibility of gunshot wounds being caused by non-lethal weapons (which is usually the case in practice).

## Conclusions

- The CT examination with standard parameters and in the remote control scan demonstrates rubber bullets and a large element of the bullet – a plastic concentrator. To make those foreign bodies visible in crosswise scans the parameters need to be altered.
- Plastic bullets were not visible in CT examination. Only a picture of one element of the bullet cal 12/70 – a concentrator – has been obtained. However, the concentrator is significantly bigger and heavier than plastic bullets.
- Bearing in mind the physical and chemical features of rubber bullets, and more importantly the coefficient of radiation reduction, the rubber bullets are rather faintly visible in CT examination when compared with metallic ball cartridges. Therefore, their diagnosis requires more effort and precision.

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## LITERATURE


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***Kompiuterinės tomografijos taikymas nustatant „nemirtinu“ ginklu padarytas šautines žaizdas***

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***SANTRAUKA***

*„Nemirtinų“ ginklų paskirtis – „paralyžiuoti“ žmogų trumpam laikui nesukeliant kūno sužalojimų ar kitų sveikatos sutrikimų. Taigi „nemirtinų“ ginklų kulkos, apibūdinamos kaip neįsiskverbiančios (non-penetrating). Vis dėlto praktika rodo, kad šie teiginiai ne visada teisingi; pasitaiko atvejų, kai „nemirtinais“ ginklais padaromos šautinės žaizdos – kulkos ar jų dalys įsiskverbia į kūną. Šio tiriamojo darbo autoriai atliko „nemirtinų“ ginklų guminių ir plastmasinių kulkų eksperimentinį kompiuterinį tomografinį (KT) tyrimą. Kulkos buvo pritvirtintos prie tiriamo asmens pilvo paviršiaus. Eksperimentinio tyrimo rezultatai parodė, kad KT tam tikru mastu yra veiksmingas metodas nustatant guminėmis kulkomis padarytas šautines žaizdas. Vis dėlto, norint nustatyti tų kulkų paliktus pėdsakus KT tyrimo metu, tyrimo parametrai turi būti patikslinti. Straipsnyje vis dėlto teigiama, kad KT taikymas nebūtinai patvirtina mažų plastikinių kulkų pėdsakų susidarymo mechanizmą.*