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THE UTILIZATION OF TACHYMETRY IN FORENSIC MEDICINE

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Summary

Introduction: Tachymetry is a geodetic method enabling to measure angles and distances. The aim of the work was to demonstrate alternatives of its utilization in daily forensic medicine practice. The work is dealing with confusing cases of gunshot injuries. It is impossible to determine the trajectory of the projectile, the sequence of gunshots, to identify shooting person etc. in these cases only on the base of autopsy findings and investigated circumstances. In these cases the investigation experiments on the crime scene in collaboration with the land surveyors were realized. The work presents two case reports.
Methods: For our measurements the electronic tachymeter TOPCON 211D was used. These were performed by the means of polar method in local coordinate system with relative heights. In the first case the position of victim was simulated by a figurant according to testimonies of witnesses and the accused. The second case dealed with suicide.
Results: In the first case there were two gunshots. The trajectory of the first gunshot was determined and the projectile was found. Hereby the most authentic testimony could be estimated. Also high grade probability of the relative position of the victim and the accused was figured out. In the case of suicide also the projectile was found and the position of the victim in the time of gunshot was determined.
Conclusion: In the both case reports demonstrated the projectiles were not found by ballistics expert investigations. All questions of expert opinions could be answered only with the help of tachymetry. The advantage of this method is its good regional availability even at places far from specialized criminal investigation workplaces.

Key words: tachymetry, gunshot injury, forensic medicine, ballistic investigation, expert opinion, regional availability of land surveyors

Súhrn

Využitie tachymetrie v súdnolekárskej praxi

Úvod: Tachymetria je geometrická metóda umožňujúca merať uhly a vzdialenosti. Cieľom našej práce je demonštrovať možnosti jej využitia v súdnolekárskej praxi. Ide o nejasné prípady strelných poranení, kedy nie je možné určiť dráhu strely, poradie striel, strieľajúcu osobu atď. len na základe pitevného nálezu a vyšetrených okolností. V týchto prípadoch vykonávame vyšetrovacie pokusy na mieste činu v spolupráci s geodetmi. V práci prezentujeme dva prípady.
Pacienti a metódy: Merania boli vykonávané elektronickým tachymetrom TOPCON 211D polárnou metódou v lokálnom súradnicovom systéme a relatívnych výškach. V prvom prípade poloha poškodeného bola simulovaná figurantom na základe výpovedí obvineného a svedkov. V druhom prípade išlo o samovraždu.
Výsledky: V prvom prípade bolo strieľané dvakrát, pričom bola určená dráha prvej strely a bol nájdený projektil. Zároveň bolo možné určiť, ktorá výpoveď je najvierohodnejšia. Taktiež bola zistená najpravdepodobnejšia poloha obvineného a poškodeného. V prípade samovraždy bol nájdený projektil a určená poloha obete v čase streľby.
Záver: Projektily v obidvoch demonštrovaných prípadoch neboli nájdené na základe kriminalistických balistických skúmaní. Pri riešení nejasných prípadov strelných poranení nám tachymetria dáva presnejšie výsledky a vyčerpávajúcejšie odpovede na otázky, ktoré majú byť zodpovedané v znaleckom posudku ako bežne používané balistické metódy. Hlavnou výhodou využitia metódy v súdnolekárskej praxi je jej regionálna dostupnosť predovšetkým na miestach, ktoré sú vzdialené od špecializovaných kriminalistických pracovísk.

Kľúčové slová: tachymetria, strelné poranenie, súdne lekárstvo, balistické skúmanie, znalecký posudok, miestna dostupnosť geodetov

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INTRODUCTION

Tachymetry is a geodetic method enabling to measure angles and distances [1, 2, 3, 4]. The aim of the work is to demonstrate alternatives of its utilization in daily forensic medicine practice. The work is dealing with confusing cases of gunshot injuries. It is impossible to determine the trajectory of the projectile, the sequence of gunshots, to identify shooting person etc. in these cases only on the base of autopsy findings and investigated circumstances. In these cases the investigation experiments on the crime scene in collaboration with the land surveyors are realized. The work presents two case reports as the examples of its utility.

METHODS

For our measurements the electronic tachymeter TOPCON 211D was used. These were performed by the means of polar method in local coordinate system with relative heights.

Case 1

It was the case of wilful murder of a 26-year-old man by

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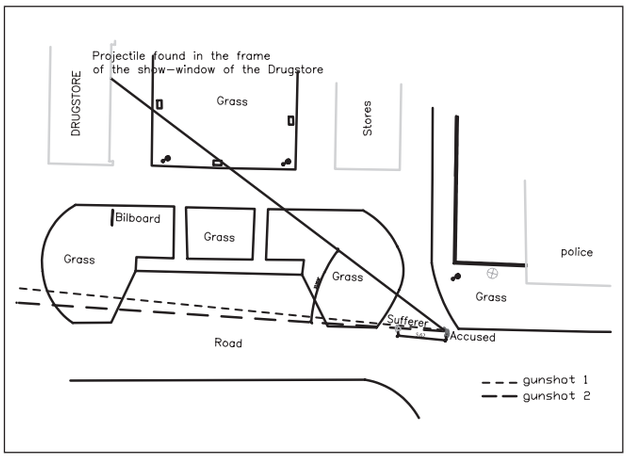


Fig. 1: Situation according to the testimony of the accused

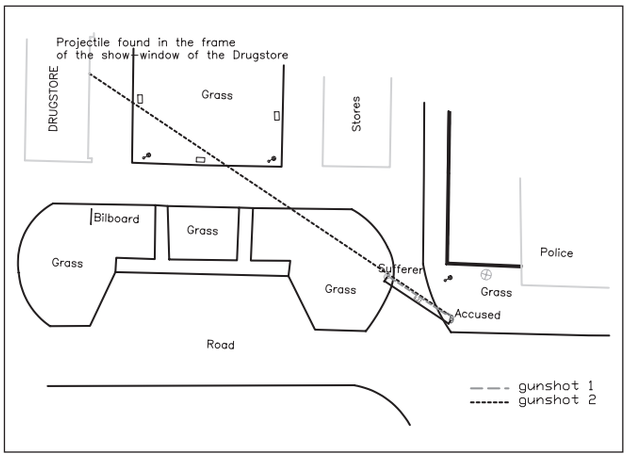


Fig. 2: Situation according to the testimony of the first witness

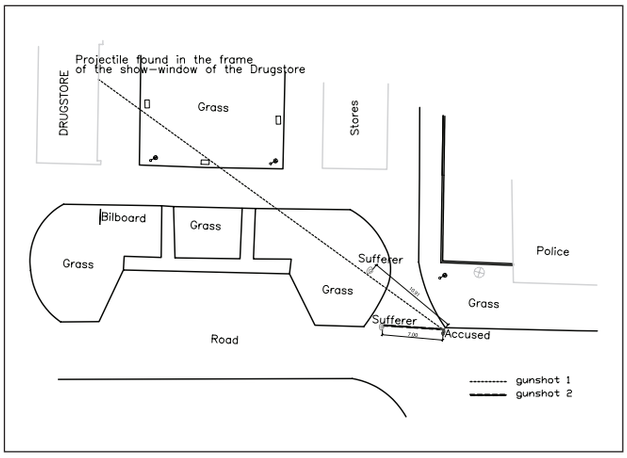


Fig. 3: Situation according to the testimony of the second witness

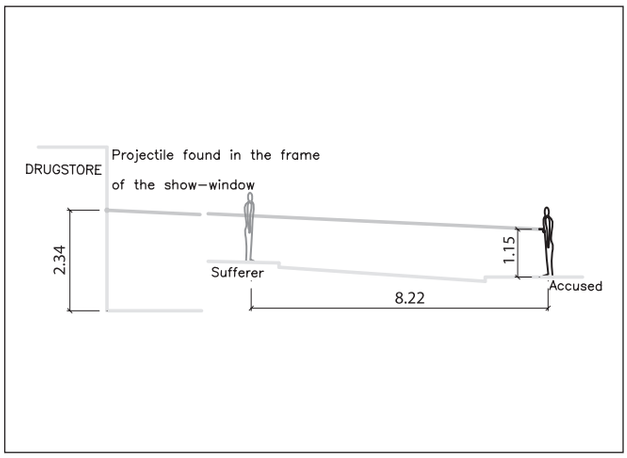


Fig. 4: Lateral view at the most authentic trajectory of the gunshot 1

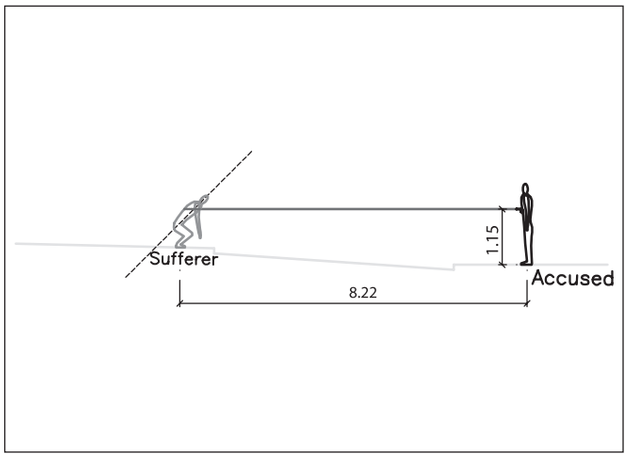


Fig. 5: Lateral view at the most authentic trajectory of the gunshot 2

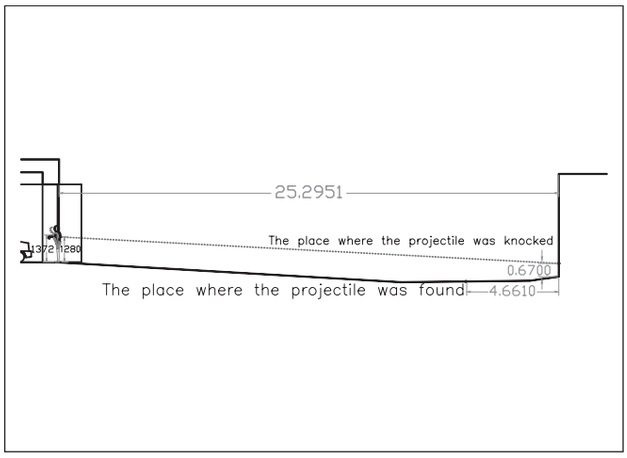


Fig. 6: Lateral view at the trajectory of the gunshot

a gun. The man suffered gutshot with perforating wound of the abdominal aorta followed by bleeding into the abdominal cavity (860 g of blood clots and 1 200 ml of liquid blood). The cause of death was haemorrhagic shock. Gunshot channel lead from the front to the back from the left above to the right downwards with the angle of 45 degrees regarding the anteroposterior level and with the angle of 45 degrees regading the horizontal level. Gunshot entrance wound was in the left upper part of the abdomen 125 cm far from the heels and 8 cm left from the midline. Projectile was found in dorsal muscles subcutaneously at the level of the upper margin of right processus costarius of the first lumbal vertebra. Gunshooting was carried out in the night at open space as the result of physical attack among the accused and the sufferer and two eyewitnesses. There were two gunshots.

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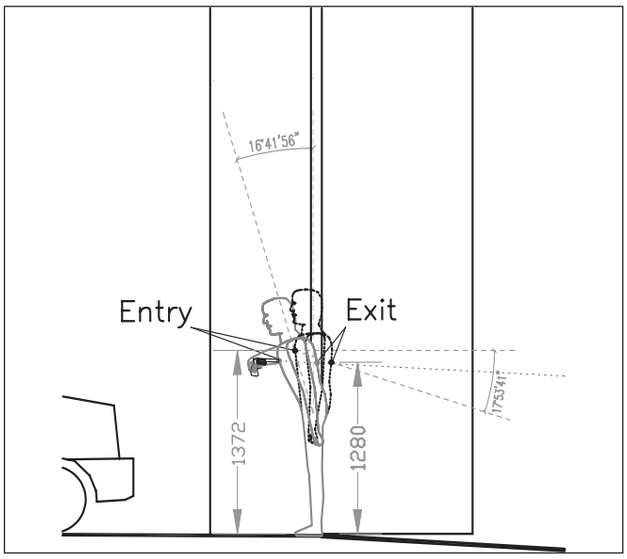


Fig. 7: Lateral view at the position of the sufferer in the time of the gunshot

The accused stated in his testimony, see Fig. 1, that he stood in the street and shoot the shot from the waist to the air. After he wanted to fix up the gun, another gunshot was shot out. As he said he almost did not move the gun.

One of witnesses reported that he registered the first gunshot at the moment when he arrived towards the accused standing on the grass in the direction from the building of the Drugstore, as seen in Figure 2. After this gunshot the sufferer crouched. Immediately after that another gunshot was heard.

According to the testimony of the second witness (brother of the accused), the first gunshot was shot at the moment when the sufferer was comming together with the first witness towards him and the accused in the direction from the building of the Drugstore. After a while he heard another gunshot and saw the flash at the heigth of the waist of the accused and after that the sufferer (in the street) crouched (see Figure 3).

To find out the most authentic testimony the investigation experiment was carried out. The position of victim was simulated by a figurant according to testimonies of witnesses and the accused. Before measurements and after recapitulation of all testimonies we tried to find the projectile which was supposed to be shot by the accused into the air as the warning shot. The projectile was found in the frame of plastic shop-window at the building of the Drugstore at the distance of about 40 m after the sufferer at the heigth of 2.34 m above the level of the pavement.

Case 2

It was the case of a 42-year-old policeman who was found dead with gunshot injury in the thorax at the garage of Authority for Safeguard of Constitutional Agents. Gunshot channel lead backwards slightly obliquely from the above downwards with the angle of 17.5 degrees regarding the horizontal level. It transferred through the right heart ventricle and upper part of the spleen. That was the cause of bleeding into the left pleural cavity (1200 ml of semiliquid blood) and abdominal cavity (150 ml of semiliquid blood). The cause of death was haemorrhagic shock. Gunshot entrance wound was in the region of the left parasternal line of the thorax at the distance of 134.7–136.4 cm far from the heels. Gunshot exit wound was in the region of the left paravertebral line of the dorsum at the distance of 125,4–126,6 cm far from the heels. The length of the gunshot channel was 29 cm.To find out the trajectory and the position of the victim in the time of gunshot we performed investigation experiment on the other day in the late afternoon after the autopsy, at the place where the dead body was found. Supposed situation was simulated according to the heigth of gunshot entry and exit.

RESULTS

Based to the results of measurements we can observe in Case 1 that if the sufferer was shot death by the second gunshot (accidental) and he stood in the street, the angle between the first gunshot (projectile in the frame of the shop-window of the Drugstore) and the second gunshot was 33 degrees. The accused stated in his testimony that he shot from the waist at the heigth of 1.25 m, i.e. the trajectory of the projectile lead from the above downwards with the angle of 1.2 degrees and therefore it could not cause the gunshot channel leading from the above with the angle of 45 degrees regarding the horizontal level, as we found out at the autopsy.

The trajectory of the first gunshot is in the agreement with the testimony of the second witness. The part of the testimony considering the second gunshot is not in correlation with the gunshot channel in the body of the sufferer.

The testimony of the first witness seemed to be the most authentic testimony. If the sufferer crouched after the first gunshot it might not have been because he was shotdown. The second gunshot could have shot him down crouching or laying and the gunshot channel occurred as it was found out at the autopsy (see Figure 4 and 5).

In the Case 2 the place of the impact of the projectile on the wall of the building was found at the distance of about 25 m from the place where the sufferer was at the time gunshooting and also the knocked projectile was found (see Figure 6). We have also found out that the sufferer was slightly bent at the angle of 16.4 degrees regarding the frontal level (see Figure 7).

CONCLUSION

In the both demonstrated case reports the projectiles were not found by ballistics expert investigations. In the first case the most probable order of gunshots was estimated regarding the hit target. All questions of expert opinions could be answered only with the help of tachymetry. Another advantage of utilization of this method in daily forensic medicine practice is its good regional availability even at places which are far from specialized criminal investigation workplaces. The aim of the work was the presentation of tachymetry as the method, which can be used as an alternative method in ballistic investigation. The authors have presented these two cases only as the examples of the possibilities of using tachymetry, which has been used in daily forensic medicine practice in their institute already for ten years.

Acknowledgements

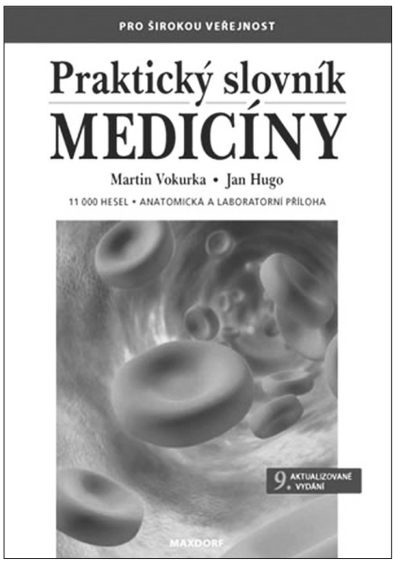
We would like to devote this work in remembrance of MUDr. Miroslav Hagara who introduced the mentioned method in our institute and established a tradition of good relationships and collaboration among medical examiners, surveyors and the bodies of Police Forces. We express our great sorrow at MUDr. Miroslav Hagara's early departure close before the end of his 40-year-long career of medical examiner. We also regret he could not see the publication of the results of his work.

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REFERENCES

1. **Farkašovský, J., Kukuča, J., Bukovinský, E.:** Geo – topo manual for geodesists and topographers. Bratislava, ALFA, 1963, 572 pp. (in Slovak)
2. **Gál, P.:** Geodesy in building industry. Bratislava, SAV, 1959, 820 pp. (in Slovak)
3. **Šulo, J.:** Topographic charting. Bratislava, SVŠT, 1980, 205 pp. (in Slovak)
4. **Šütti, J.:** Geodesy, Bratislava, ALFA, 1968, 368 pp. (in Slovak)

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Martin Vokurka, Jan Hugo a kol.

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