



Can cadaverous pollution from environmental lead misguide to false positive results in the histochemical determination of gunshot residues? Study on cadaveric skin samples



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ABSTRACT

Histochemical determination of lead in gunshot residues (GSR) raises the question of possible environmental contamination by heavy metals. Authors assess the specificity of the Sodium Rhodizonate Test in the search of lead derived from environmental pollution.

Sodium Rhodizonate Test and 5% HCl Sodium Rhodizonate test were applied to skin samples taken from two groups of victims, whose cause of death was not related to gunshot wounds: group A included 25 corpses found in open spaces after a long time; group B included 16 corpses exhumed after a period of 11 years.

The use of these histochemical tests to skin samples from these two groups did not show metal debris histochemically similar to the lead present in GSR.

These tests were confirmed to be specific in highlighting the GSR coming from gunshot, without being affected by the potential environmental contamination of the heavy metal pollutants, coming from air or soil.

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1. Introduction

The histochemical Sodium Rhodizonate test (Na-R) and 5% HCl Sodium Rhodizonate Test (Na-R-HCl), are techniques used in Italy and considered very useful in the study of gunshot wounds, in the determination of the shot distance [1,2] and in the differential diagnosis between the entry and exit hole [3]. These techniques are considered fundamental since energy-dispersive X-ray spectroscopy (SEM/EDX) has high costs and is not available in all laboratories. The features of gunshot wounds are macroscopically appreciable when the body is well preserved, but if the bad cadaveric conditions do not allow to understand the nature of the lesions [4], it is necessary to address such bodies (if a gunshot wound is suspected) to the histological detection of gunshot residues in a region protected from environmental pollution, such as the way of the projectile inside the body. In fact, the GSR have been histochemically found within the first two cm behind the

entry hole [3]; moreover, it is also possible to enhance the chromatic contrast staining the connective tissue with triphenylmethane [5].

The techniques described above exploit the ability of the Sodium Rhodizonate to react with lead and other constituents of the GSR, obtaining a scarlet red [6] fine granular pattern [7]. Subsequently, it is necessary the confirmation of the nature of the lead by a HCl solution at 5% [8]. It is possible to come across some problems during the search of the charge trigger residues as part of the primer (Gunshot residues—GSR), because there could be a false positivity to the lead, caused by deposits on the skin of particles of this metal present as environment pollutants. The sources of environmental contamination generate, in fact, residues similar to those of the GSR arising from the primer, that remain suspended in the air for an indefinite period and that fall on the soil, by gravity, contributing to the risk of false positivity [9]. It happens overall in corpses exposed, for a long time, to the external environment.

The social alarm due to the prolonged excess of the PM10 level (Particulate Matter) over the alert level in Milan, forces the adoption of restrictive measures and protocols designed to improve air quality and tackle local air pollution. In fact, the

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Table 1

Data about air concentration of PM10 in 2015 in Milan and neighboring towns extrapolated from official data of the Province of Milan- Section Environment.

Geographic collocation		No of cases	No samplings/year	Annual average value ($\mu\text{g}/\text{m}^3$)	No days over the limit ($>50 \mu\text{g}/\text{m}^3$)	Average value over the limit ($\mu\text{g}/\text{m}^3$)
Milan	City center	16	357	40 (range = 7–145)	101	71
	Suburbs	13	343	42 (range = 5–152)	100	74
Hinterland	Close extra-urban area	10	354	36 (range = 1–102)	73	69
	Distant extra-urban area	2	359	33 (range = 3–97)	61	66

statistics published by the Province of Milan – Section Environment [10] – concerning the air quality in 2015 for the City and the neighboring towns indicate the surplus of the maximum allowed level ($50 \mu\text{g}/\text{m}^3$) of more than three times their value ($152 \mu\text{g}/\text{m}^3$) and for a prolonged period of time (till 101 days in a year). In accordance to the areas where the corpses were found, the Authors have focused on the environmental data on those territories, dividing the city in a Central Area and a Suburban Area. Moreover, the Authors have taken into consideration the neighboring towns and a solely medium size urban center east of Milan (Table 1).

This aspect has led the Authors to wonder about the actual possibility that the particulate, composed of heavy metals such as lead, may contaminate the soil and the bodies exposed to the environment for a long time.

The aim of the study, in this report, was to evaluate, by the Sodium Rhodizonate Test and 5% HCl Sodium Rhodizonate Test, the eventual positivity to the presence of lead from the environmental pollution on skin samples taken from two groups of corpses without gunshot injury. The first group (group A) included corpses exposed to the external environment in different parts of the city from a period of 10 days to 3 years; the second group (group B) included exhumed corpses from one of the main cemeteries of the city center of Milan, after a period of 11 years.

The results obtained were compared to samples taken from cadavers deceased from gunshot wounds.

2. Materials and methods

The bodies considered were divided into two groups: group A included 25 Caucasoid victims (17 males and 8 females) aged from 13 to 89 years, whose autopsy was in 2015, at the Section of Legal

Medicine, State University of Milan. The cause of death of all of them was different from gunshot harmfulness and they had been found outside, after a period of time between 10 days and 3 years, in variable degrees of decomposition, till the partial skeletonization.

The Group B included 16 Caucasoid corpses (7 males and 9 females), aged between 62 and 92 years, who had been exhumed from one of the main cemeteries of Milan, after a period of 11 years; their degree of preservation ranged from the saponification, to the corification and the partial skeletonization (Fig. 1). The Health Authority had previously allowed the forensic pathologist to take samples for scientific purposes.

In group A the victims had died to causes unrelated to gunshot wounds: in detail, they were homicide victims in 11 cases (5 blunt force injuries, 4 sharp force injuries, one car accident and one thermal injury) and 5 cases of suicide, (3 mechanical asphyxia by hanging and 2 falls from a high); the remaining 9 victims had died of natural causes (8 acute myocardial infarctions and 1 pneumonia). The victims of the group B showed no macroscopical signs of necropsy or signs due to a violent death (Table 2).

Finally, in order to identify whether in Milan and hinterland there are areas polluted by heavy metals that could settle on the bodies exposed to the air and the soil, for all cases the discovery place or the burial place was registered. In addition, the data concerning the three major geographical city areas were taken from the official records on the environmental pollution of the city of Milan, which showed, in 2015, annual levels of PM10 with an average of $43 \mu\text{g}/\text{m}^3$ at the northern side, $41 \mu\text{g}/\text{m}^3$ at the center and $37 \mu\text{g}/\text{m}^3$ for the southern side (the annual average of PM10 has a limit of $40 \mu\text{g}/\text{m}^3$).

Prior to the autopsy, before the corpses were rinsed for the dissection, on each cadaver, skin samples sized $1 \times 0.5 \text{ cm}$ were



Fig. 1. Corpse (Group B) during the exhumation after 11 years.

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