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Gunshot Injury of the Head : Case Report and Statistical Analysis of Gunshot Injury in Japan

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Abstract A single case of fatal gunshot wounds of the head involving both homicidal and suicidal natures is reported. X-ray and CT-scan examinations were performed on the victim in a hospital. The gunshot tract and lacerated tissue about the missile path with bone and metallic fragments shown on the CT-scan were confirmed at the autopsy. The mechanisms of brain injuries caused by gunshot are discussed in this report.

A statistical analysis of the firearm fatalities in Japan was conducted using 273 cases obtained from the annual report concerning the expert opinion on forensic autopsy cases published by the Medico-Legal Society of Japan. The mean age of the fatalities was 40 years old, and the peak incidence was observed between the 30's and 40's. Males predominated in sex distribution. As for the manner of death, 86% of the cases were homicide, 6% suicide and 7% accident. The number of fatal firearm accidents during hunting was very few. Pistols were the most common weapon and were responsible for 73% of the fatalities. Shotguns accounted for only 19%. As for the site of wound, the chest including the heart, was a favoured site (62%). The head was involved in 42% of all cases. Hemorrhage was the leading cause of death followed by brain damage. With regard to alcohol and the Yakuza (Japanese mafia), 15% of the firearm victims were under the influence of alcohol. Yakuza were involved in more than 70% of all cases.

A statistical analysis of firearm fatalities in Japan determined the following characteristics 1) the high incidence of homicide and low incidence of suicide and hunting-related fatalities, 2) involvement of Yakuza in firearm fatalities, 3) pistols were the most common weapon involved.

Key Word : Gunshot, Head injury

Introduction

In Japan, the possession and use of firearm without licence is strictly prohibited. As a result of this rather restrictive legislation, gunshot wounds are a very uncommon type of injury in Japan. The present case involved both homicidal gunshot wounds and suicidal one as well. Clinically, x-ray and computed

tomographic (CT) scan were performed prior to forensic autopsy.

First, the diagnostic values of these examinations and some mechanisms of gunshot injury in the brain are discussed in this paper. Secondly, a statistical analysis of fatal firearm cases between 1980-1988 was attempted in order to characterize the fatal firearm case in Japan.

Materials and Methods

1) Case Report

2) Statistical Analysis ; Statistical analysis was performed based on the annual report concerning the expert opinion of forensic autopsy cases published by the Japanese Medico-Legal Society. Some of the information was provided by the Yamaguchi Police Headquarters.

All cases were reclassified according to age, sex, the site the of wound, the etiology of death and the type of firearms. The manner of death was attributed to suicidal, homicidal or accidental cases. In addition, the involvement of alcohol and the Japanese mafia called "Yakuza" in fatal firearm cases were also considered.

Case report

A 34-year old man was shot in the forearm and the shoulder during a gunbattle with two men. As he was about to be captured, he committed suicide in desperation by shooting himself in the left temple with his 0.38 caliber revolver. He was admitted to the emergency room of a hospital, where complete x-ray and CT-scan examinations were performed on him. Although intensive treatments were given in the hospital, he died 30 hours after his hospital admission.

Clinical course : When he arrived at the emergency room, the patient was in deep coma. Consciousness were equal to 3 points of Glasgow Coma Scale. He was breathing spontaneously and irregularly. The blood pressure was 60/24 mmHg, and the pulse rate was 114 per minute and regular. The pupils were dilated and unresponsive to light. Corneal and oculocephalic reflexes were absent. Deep tendon reflexes were remained in the upper extremities, but absent in the lower extremities. A laceration of the left superficial temporal artery was noted at its diverging point, and massive bleeding due to the laceration was observed in the left temporal scalp. He was intubated and ventilated with an artificial (Bird) respirator. Lactate ringer solutions containing 3 mg/ml of dopamine hydrochloride and 1,000 ml of whole blood were given intravenously. Although the systolic pressure was sustained between 80

and 90 mmHg for the first several hours, oliguria developed gradually in the patient, followed by a fall in blood pressure within 2 hours. The patient died 30 hours after his admission to the hospital. X-ray films of the skull showed a wide-range compound fracture as well as metal and bone fragments (Figs. 1-a, 1-b). The CT-scan revealed both the track of the gunshot wound and hemorrhages in the lateral ventricles. Around the would track, radiopaque materials and air density indicating fragments of metal and bone were seen (Figs. 2-a, 2-b).

Autopsy Findings : A medico-legal autopsy commenced 12 hours after death.

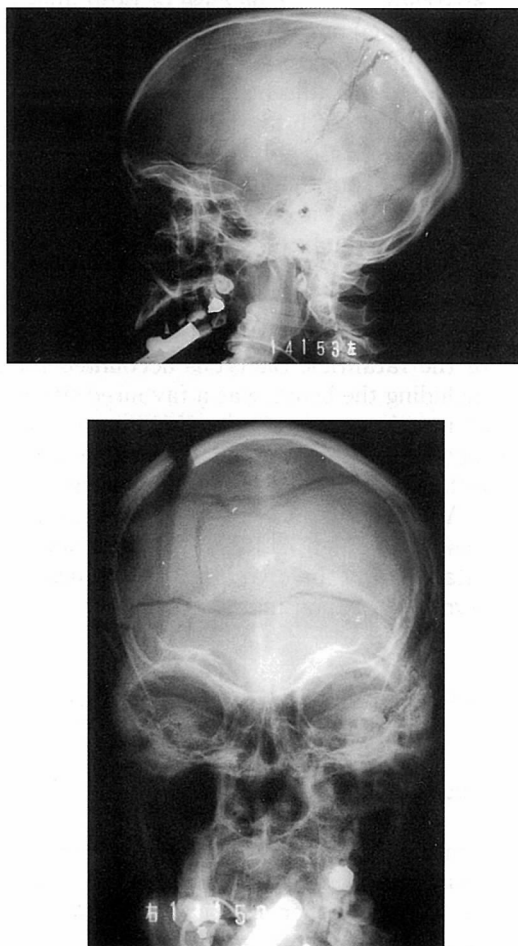


Fig. 1 X-ray films of the skull showed the bone fracture of the right parietal bone, and radiopaque materials.

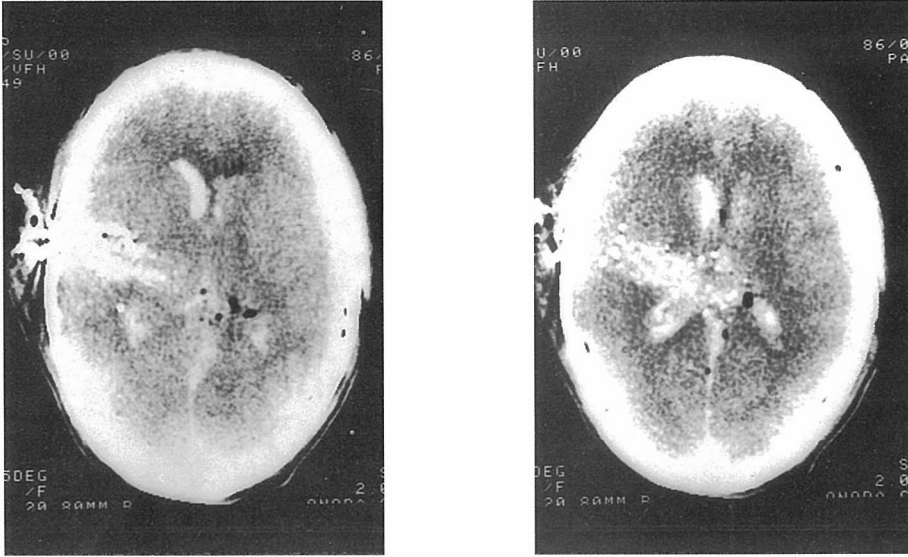


Fig. 2 The computed tomographic (CT) scan showed a gunshot tract and hemorrhage of the lateral ventricles.

The body was that of a well-nourished male of average build, measuring 163 cm in height and weighing 65 kg. Postmortem rigidity was clearly observed, and hypostasis which was present posteriorly disappeared with digital compression.

In the head, an entrance wound measuring 4.5×0.5 cm was located on the left temporal scalp. A burn was present around the entrance wound, which indicated a contact gunshot. An ovoid exit wound measuring 2.0×0.8 cm was present on the right parietal scalp. A diffuse subcutaneous hemorrhage was observed in the scalp around the entrance and exit wounds. The projectile entered through the temporal bone making a defect of 2.5×2.0 cm on the outer table and 2.0×1.0 cm on the inner table. It then perforated the brain from the left temporal to the right parietal lobe, and finally exited the right parietal bone through a defect measuring 1.1×1.5 cm on the inner table and 1.0×1.5 cm on the outer table. There were three radiating linear fractures associated with the entrance defect of the left temporal bone. The anterior fracture extended along the left squamous suture; the middle radiated upward terminating at the right squamous suture; and the posterior one, circumferentially around the posterior skull from the

entrance defect to the right squamous suture. At 2.0 cm and 4.5 cm left from the exit defect two linear fractures were present. The first extended anteroposteriorly for a length of 17.0 cm and the second in the same direction for 9.0 cm. In the fossa cranialis posterior and media, two linear fractures were found with lengths of 5.0 cm and 6.0 cm, respectively. Epidural, subdural and subarachnoid hemorrhages were noted around the exit wound in the right side of the brain.

A brain cutting was conducted after one week fixation with 10 % formaldehyde solution. The gyri were flat and the sulci were closed. The direction of the gunshot wound was confirmed by the tunnel-like wound extending from the left temporal lobe to the right parietal lobe via the lateral ventricle and the basal ganglia (Figs. 3-a ~ 3-b). The angle produced by the direction of the gunshot and horizontal plane at the entrance wound was determined to be 18 degrees. The brain tissues in the track margins were ragged and hemorrhagic. Fragmented bones were recognized microscopically at the track margins. There was a massive hemorrhage extending from the lateral ventricles to the fourth ventricle as well as in the sylvian fissure around the entrance wound. Petechiae were present in the bilateral cin-

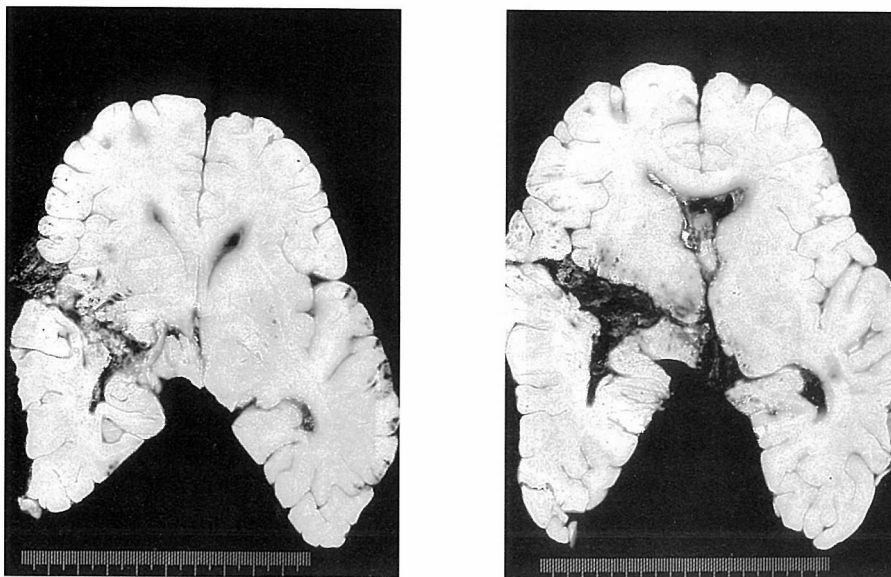


Fig. 3 A gunshot tract and hemorrhage shown in the horizontal section were the same as in the CT-scan. Many petechiae were present at the top of the gyri in the temporal and parietal areas.

gulate gyri and right temporal area. These injuries were considered to have been produced by contracoup mechanism. A hemorrhage was observed in the left midbrain (Fig. 4). At 8.0 cm distal of the right acromion, an entrance wound of homicidal gunshot was located. Its size was 0.8×0.5 cm. A deformed bullet was recovered in the nucha at the position of 2.5 cm below of the vertebra prominens and 1.0 cm left from the midline. There was no exit wound on the surface of the nucha, but a discoloration measuring 2.0×2.0 cm was present in the left side of the nucha. In the right antebrachium, a penetrating wound of homicidal gunshot was also observed. No vital lesions were noticed with these homicidal gunshots to the nucha and the right arm.

The weight of the heart was 315 g. A chicken fat clot was found in the right ventricle. The weight of the lungs were 535 g for the left and 660 g for the right, and ischemic changes were noted in both lungs. In the gastrointestinal tracts, particularly in the gastric mucosa, many petechiae were noted. The weight of the liver was 1,615 g, and other

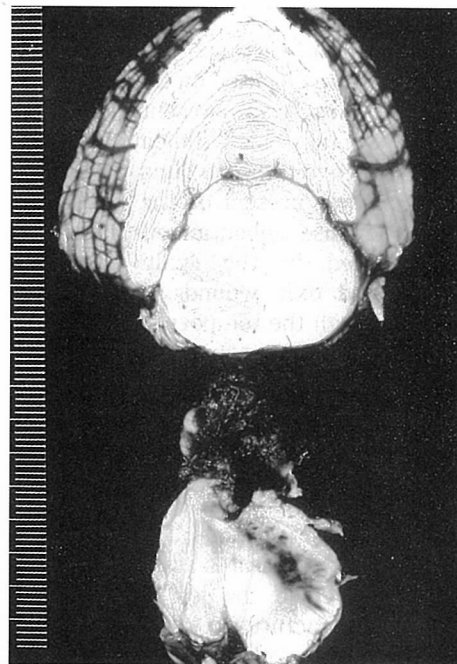


Fig. 4 The findings of the midbrain. A hemorrhage is in the left midbrain, which was not demonstrated in the CT-scan.

than ischemic changes, no pathological changes were observed. The weight of the kidneys were 160 g and 155 g, respectively. A lot of petechiae were present at the renal pelvises.

Statistical Result

The material used for our analysis consisted of 273 autopsied cases which occurred between 1980-1988 as compared with 885 firearm-related fatal incidences. Although there was a variation in the numbers of autopsied case for each year, more than 20 cases per year were available for the statistical analysis. With regards to the manner of death, 235 homicidal cases were observed, which represented 86% of the entire available material. Suicidal and accidental cases represented 6% and 7 of all cases, respectively (Table 1).

The age distribution of firearm fatalities revealed that the highest incidence occurred between the 30's and 40's (mean age; 40 years old, Table 2). 91% of them were male. As for the involvement of alcohol in firearm fatalities, about 15% of the firearm victims were under the influence of alcohol. In addition, in more than 70% of the fatal firearm cases, Yakuza were involved.

Table 3 lists the weapons involved. 73% of the firearms were pistols, while shotguns accounted for 19% of all the weapons used. The site of the firearm wounds are listed in Table 4. In 62% of the cases, the firearm were noted in the chest, including the heart, while there were firearm wounds in the head in 42% of the cases. Lethal trauma to the abdominal part including lower extremities were also observed in 34% of the cases.

Table 5 presents the cause of death. Death due to hemorrhage was the dominant cause of death (52%), followed by brain damage (30%), heart injury and cardiac tamponade.

Discussion

Gunshot wounds constitute only about 1% of the autopsy cases in Japan¹⁾, comparing with annually some 30,000 of fatally wounded people in USA²⁾. The usefulness of x-ray examinations at the autopsy of gunshot case

Table 1 The manner of death caused by gunshot in Japan.

	Number	Percentage
Suicide	16	6
Homicide	235	86
Accident	20	7
Undetermined	2	1

Table 2 Age distribution of firearm fatalities.

Age	Number	Percentage
10's	8	3
20's	42	15
30's	87	32
40's	84	31
50's	33	12
older than 60's	19	7

Table 3 The type of firearm used.

	Number	Percentage
Pistols	198	73
Shotgun	53	19
Rifle	5	2
The others	16	6

Table 4 The site of wound.

	Number	Percentage
Head	115	42
Chest	170	62
Abdomen	93	34

are well documented in the field of forensic pathology¹⁾³⁾⁴⁾. This paper reports a case in which complete x-ray and CT-scan examinations had been performed on the victim in a hospital prior to his medico-legal autopsy.

In a case of gunshot wound, the following three points must be taken into consideration at a medico-legal autopsy; 1) the type of ammunition involved, 2) the direction from which the bullet was discharged and 3) the distance from which the firearm was discharged. The firearm used for suicide in the present case was a revolver which had a low muzzle velocity, 600-1,000 ft/sec. The bullet's ability to destroy tissues is directly related to the kinetic energy expressed in the for-

Table 5 The causer of death.

	Number	Percentage
Hemorrhage	142	52.0
Brain damage	81	29.7
Cardiac tamponade	7	2.6
Heart injury + Hemorrhage	7	2.6
Brain damage + Hemorrhage	4	1.5
Heart injury	8	2.9
Abdominal injury	6	2.1
The others	19	6.6

mula of $1/2 MV^2$, where M is the weight of the bullet and V is the velocity of the bullet⁵⁾. As the revolver was discharged in contact with the scalp in this case, the kinetic energy was large enough to penetrate the head. The bullet went through from the left temporal to right parietal lobe.

Generally speaking, characteristic bone defects are produced by a bullet perforating the skull. An entrance wound is bevelled inward resulting in a larger bone defect on the inner table than on the outer table. In contrast, an exit wound is bevelled outward and is larger on the outer than on the inner table. In a case of contact shot to the head, however, the entrance hole in the skull is bevelled both inward and outward. This is due to the chipping of the outer layer of bone around the defect by the forceful return of gases through the bullet hole and or by the twisting force of the rotating bullet⁶⁾. The external beveling of the entrance would be recognized and the exit wound had a punched-out appearance in this case. The particular findings in the entrance and exit wounds in this case confirmed that the bullet struck the skull at a right angle.

The entrance wound of the scalp in the present case was a lacerated wound, and was considered to have been caused by the blast effect, which followed the sudden release of gases into a confined area between the skin and the skull^{6,7)}. As for the radiopaque one space materials in this case, they were fragments of bones and metal from the bullet produced by the forceful impact of the bullet on the skull. It was considered that these fragments might act as secondary missiles in the brain and exaggerated the wound in the brain.

Midbrain lesions of hemorrhagic types, which are usually lethal, are often found in severe and closed head injuries. It is still a matter of controversy whether these lesions are primary ones caused by the impact itself or secondary lesions usually caused by the result of transtentorial herniation due to an increased supratentorial pressure. Bakey et al⁸⁾, indicated that the brain stem injury was the result of the secondary causes rather than primary ones. But in cases of high velocity wounds, the intracranial pressure increases instantaneously to more than 3,000 mmHg starting from the temporary cavity around the bullet. The cavity formation produced by the radial motions of the bullet creates oscillation of both positive and negative pressures along the gunshot tract, which will cause both compression and stretching of the tissues of, adjacent to, and remote from the gunshot tract⁹⁾. The midbrain injuries, including wide-ranged hemorrhages, in gunshot cases seem to have been produced by the mechanisms described above.

The statistical analysis provided us with the following characteristics of firearm-related fatalities in Japan. The sex distribution with 92% of the victims being men is in agreement with previous reports. With regard to the age distribution, it was found that the peak age in incidence was between the 30's and 40's (mean age ; 40 years old) was older than those reported previously (27 years to 31 years)¹⁰⁾¹¹⁾¹²⁾. Furthermore, the mean age of the Yakuza-related firearm fatalities is 38 years old, and 64% of them occur between the 30's and 40's. This situation is considered to lead to the elevated mean age of firearm fatalities in Japan.

The dominating manner of death is homi-

cide, while the percentage of suicidal and accidental cases is very low. This is partly due to the illegal possession of firearms by the Yakuza and the frequent use of firearms in the strife among Yakuza. In addition, the low incidence of hunters using firearm may contribute to this trend. Actually, in more than half of the cases involving suicide¹³, asphyxia caused by hanging is the dominant method. Therefore, the difficulty in procuring firearms and the traditional philosophy toward death should be taken into consideration in the discussion of low incidence of suicide by firearm. Alcohol has been considered as a contributing factor during firearm accidents. In our study, alcohol was involved in 16% of the cases. This value is low as compared to previous reports (48% for Ruthforth et al. and 35% for Copeland)^{11,14}.

In the present study, it was found that pistols were the most common weapon (73%). This situation holds true for the United States^{11,14}. However, in such countries as Denmark¹⁰ and Sweden¹⁵, it is reported that shotguns and rifle cause more than half of the firearm fatalities. Although these differences are related to the type of legislation in these countries, the involvement of Yakuza in smuggling pistols from foreign countries seems to have contributed to the high percentage of pistols as a firearm in Japan. As for the site of wound, most fatal wounds were localized in the chest and head in agreement with previous reports¹⁵. In the present study, hemorrhage was the leading cause of firearm fatality, followed by brain damage. According to Eisele et al¹⁶ and Thoresen¹⁷, the head is a favoured site. In our study, the head sustained the wound in 42% of the cases.

In conclusion, the present statistical study revealed the following 3 distinctive features in firearm fatalities in Japan.

- 1) A high percentage of homicide involving firearms and a low incidence of hunting-related accidents
- 2) Involvement of Yakuza in firearm fatalities
- 3) Pistols were the most commonly used weapon

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