The significance of subendocardial hemorrhages detected in forensic autopsies

Pomen subendokardialnih krvavitev, odkritih pri forenzičnih obdukcijah

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Abstract

Introduction: In our study, our aim was to reveal the relationship between subendocardial hemorrhage (SEH) which can be seen macroscopically immediately beneath the endocardium, and emerges secondary to many conditions from direct cardiac, head and abdominal traumas to hyperemia, and its location with cause of death, its diagnostic value (if any), and whether it can be evaluated as a vital finding.

Material and Method: 285 autopsy cases diagnosed as SEH, which were brought to the Council of Forensic Medicine of Turkey, Bursa Morgue Department, Bursa, Turkey were included in the study.

Results: Study population consisted of 229 (80.4 %) male and 56 (19.6 %) female patients. Thity-one cases of death were related to natural causes, while the most frequently detected pathological causes of death were isolated abdominal traumas (32.9 %), followed by isolated head traumas (31.9 %). While traffic accidents ranked first (35.1 %) among the events leading to death. Among the evaluated cases, SEH was mostly located on the septum.

Discussion: To fully understand the yet inadequately elucidated pathogenic mechanisms of SEH, it should be accurately defined by histopathological analysis. Even though various causes of death seen in association with these lesions suggest more than one underlying pathogenic mechanism, because of their nonspecific characteristics, their possible roles as indicators of vitality (if any) should be reinforced by further studies.

Izvleček

Uvod: Cilj naše raziskave je bil odkriti povezavo med subendokardialno krvavitvijo (SEH), ki je makroskopsko vidna neposredno pod endokardijem, pojavi pa se kot posledica različnih stanj, kot so direktne poškodbe srca, glave in trebuha, kot tudi zaradi hipertermije, ter lokacijo SEH z vzrokom smrti, njeno morebitno diagnostično vrednost in ali jo je mogoče oceniti kot ključno ugotovitev.

Material in metode: V raziskavo je bilo vključenih 285 primerov SEH, ugotovljenih pri obdukcijah, ki so jih opravili v specializiranem oddelku mrtvašnice pri Državnem inštitutu za forenzično medicino..... .

Rezultati: V raziskovani populaciji je bilo 229 (80,4 %) moških in 56 (19,6 %) žensk. V enaintridesetih primerih je bil vzrok smrti naraven, med tem ko so bili najpogosteje ugotovljeni patološki vzroki smrti izolirane poškodbe trebuha (32,9 %), sledile pa so jim izolirane poškodbe glave (31,9 %). Med dogodki s smrtnim izidom so bile na prvem mestu prometne nesreče (35,1 %). V raziskovanih primerih se je SEH večinoma nahajala na srčnem pretinu.

Razprava: Da bi lahko bolje razumeli še ne dovolj pojasnjeno patogenezo SEH, jo je treba natančno opredeliti s histopatološko analizo. Če-

prav različni vzroki smrti ugotovljeni v povezavi s temi lezijami kažejo na to, da ne obstaja le en sam osnovni patogeni mehanizem, je treba zaradi njihovih nespecifičnih značilnosti njihovo morebitno vlogo kot kazalnikov vitalnosti (če ta sploh obstaja) podkrepiti z dodatnimi raziskavami.

Introduction

Subendocardial hemorrhage (SEH) is defined as bleeding which may be macroscopically seen just beneath the endocardium, mostly in the left ventricle.[1-8] SEH can occur as a result of resuscitative interventions and direct cardiac traumas or it can occur secondary to many conditions, including head, and abdominal traumas, infection diseases, intoxications, bleeding diathesis, asthma, hypovolemic shock, burns, electric shocks, and hyperthermia.[1-12] In a study performed by Maixner, cases of death related to blood loss were reported at an incidence of 60 %,[13] while in a retrospective autopsy study conducted by Harruf, SEH was reported at various incidence rates in fatal brain injuries (60 %), intoxications (14 %), and abdominal traumas (12 %).[3] Priorly, these bleeding episodes were thought to occur as a result of rupture of congested subendocardial blood vessels secondary to heart failure or acute contractions of empty ventricles devoid of the buffering action of blood in hypovolemic shock.[2,14] Subsequent studies have suggested that SEH develops as a result of catecholamine hypersecretion mediated by the autonomic nervous system, considering a higher incidence of SEH in cases with head traumas.[2,15-24] It has been claimed that SEH constitutes the third component of the Virchow triad together with pulmonary edema and gastric eroisons in cases with increased intracranial pressure and head traumas, which reinforces the above-mentioned theory.[2,7] On the other hand, apart from this theory, diverse pathogenic mechanisms of SEH have been underlined. Some investigators have advocated that subendocardial tissue necrosis which occurs following acute hypotension leads to these bleeding episodes.[2,25] Despite these asserted theories, pathogenesis of SEH has not been fully understood yet. In our prospective study of SEH cases, we aimed to reveal the relationship between SEH and its location with cause of death, its diagnostic value (if any), and whether it can be evaluated as a vital finding.

Material and method

This study included 285 autopsy cases which were brought to the Council of Forensic Medicine of Turkey, Bursa Morgue Department, Bursa, Turkey with the diagnosis of SEH between the years 2009 and 2011. Cases with evidence of blunt and/or penetrating chest injuries, those who had been resuscitated, and decayed corpses were not included in the study. The hearts of the dead bodies were dissected using routine autopsy protocol, and cases with subendocardial SEH were evaluated macroscopically. In cases with SEH, the relationship between subendocardial location of SEH, and age, gender, cause of death, causative event of death, and body region exposed to trauma in cases with traumatic deaths, were analysed, and evaluated. The study was performed after approval of the Curriculum Committee of the Institute of Forensic Medicine.

Statistical analysis

Statistical analysis was performed using SPSS 19.0 version for Windows program. Continuous variables were presented as median, range and means (± standard deviation). One sample *chi*-square tests were used for the comparison of the distributions of categorical variables. After checking the normality of assumptions for the continuous variables, Mann-Whitney U test was used for the comparison of nonparametric variables. A p value of < 0.05 was considered significant.

Results

A total of 285 established cases of SEH were evaluated. Cases of death were of male (n = 229; 80.4 %) or female (n = 56; 19.6 %)

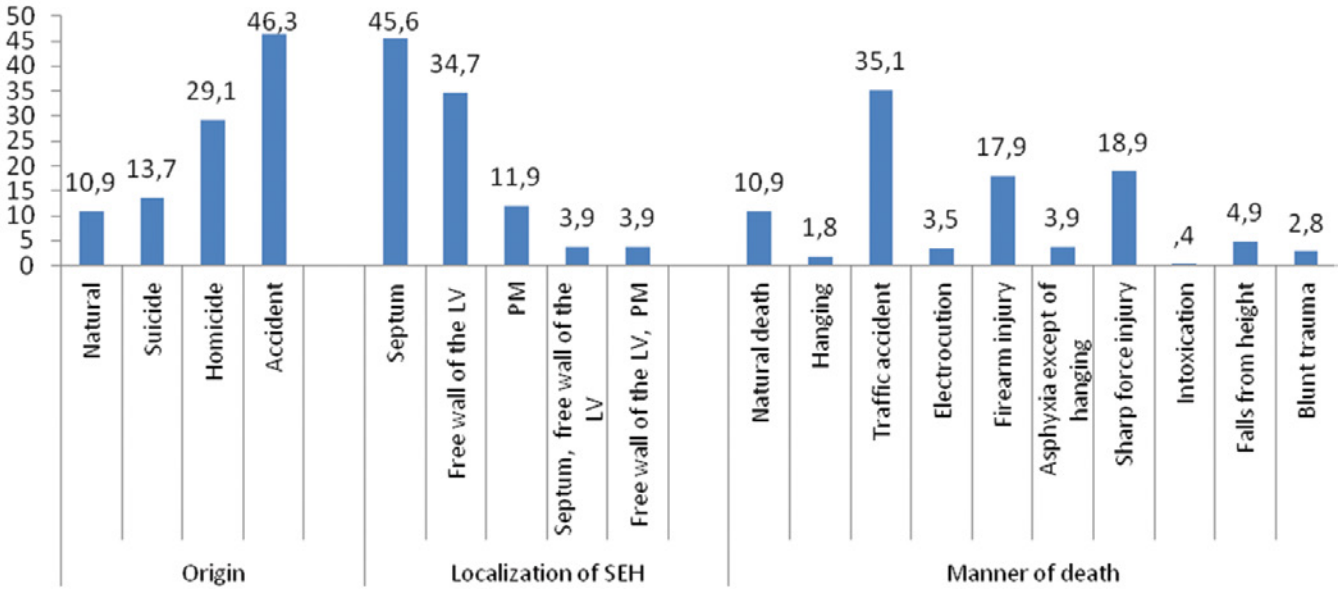

Table 1: The distribution of the cases according to the origin, localization of subendocardial hemorrhage (SEH) and manner of death.

gender, with a male/female ratio of 4.09 ($p < 0.001$). Median age of all cases was 38 (mean: 40.33 ± 16.08) years. Median ages of the male and female study populations were 38 (7–83 yrs) and 42 (4–81 yrs) years, respectively ($p = 0.069$). Causes of death were determined as natural causes (n = 31; 10.9 %), isolated blunt head trauma (n = 56; 19.6 %), isolated abdominal trauma (n = 42; 14.7 %), blunt head and abdominal trauma (n = 19; 6.7 %), blunt extremity trauma (n = 3; 1 %), blunt neck trauma (n = 2; 0.7 %), isolated penetrating head trauma (n = 35; 12.3 %), isolated penetrating abdominal trauma (n = 52; 18.2 %), penetrating head and abdominal trauma (n = 5; 1.8 %), penetrating abdominal and extremity trauma (n = 11; 3.9 %), penetrating neck trauma (n = 2; 0.7 %), electrocution (n = 10; 3.5 %) , hanging (n = 5; 1.8 %), asphyxias other than hanging (n = 11; 3.9 %), and intoxication (n = 1; 0.3 %). In 31 death cases related to natural causes, cardiac (n = 9) or non-cardiac (n = 22) pathologies were detected (Table 1). Events leading to death were related to natural causes (n = 31; 10.9 %), traffic accidents (n = 100; 35.1 %), stab wounds (n = 54; 18.9 %), firearm injuries (n = 51; 17.9 %), fall from a height (n = 14; 4.9 %), asphyxias other than hanging (n = 11; 3.9 %), electric shocks (n = 10; 3.5 %), other blunt traumas (n = 8; 2.8 %), hanging (n = 5; 1.8 %), and intoxication (n = 1; 0.4 %) ($p < 0.001$) (Figure 1). As etiological factors in 285 cases of death with established SEH, accidents (n = 132; 46.3 %), criminal acts (n = 83; 29.1 %), suicides (n = 39; 13.7 %), and natural causes (n = 31; 10.9 %) were detected ($p < 0.001$) (Figure 1). In the cases included in the study, SEH was most frequently localized on the septum (n = 130; 45.6 %) (Figure 2), followed by the left ventricular free wall (n = 99; 34.7 %). Other locations in order of decreasing frequency were: papillary muscles (n = 34; 11.9 %), septum and left ventricular free wall (n = 11; 3.9 %), and left ventricular free wall and papillary muscles (n = 11; 3.9 %) ($p < 0,001$). The distribution of cases with detected SEH with respect to events of death and locations of SEH is summarized in Figure 3.

Discussion

The significant impact of SEH whose pathogenic mechanism has not been fully understood yet, has been emphasized in forensic autopsies. The evaluation of these lesions has asserted these lesions as indicators of a potentially fatal mechanism *per se*, guiding symptoms leading to disclosure of noncardiac traumatic events with nonvisible signs or causative events of death in autopsy cases, which can not be assessed with a naked eye (electric shocks, and intoxications).[26] However, the critically significant role of SEH has been suggested as a potential indicator of vitality in cases of death related to fatal blood losses.[26]

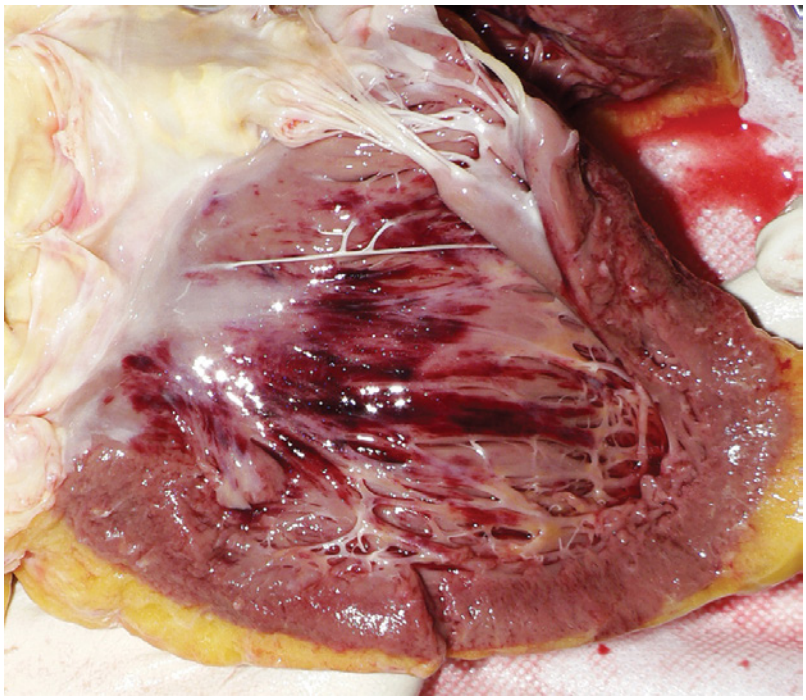

Figure 1: Subendocardial hemorrhage localized on septum

In our study, among cases with established SEH, most frequently, isolated abdominal traumas (32.9 %), followed by isolated head traumas (31.9 %) were found as causes of death. When in the established cases with SEH, blunt and penetrating traumas were evaluated individually, isolated head traumas (19.6 %) took the first and isolated abdominal traumas (14.7 %) the second place among blunt traumas. However, isolated abdominal and head traumas ranked first and second among penetrating traumas (18.2 and 12.3 %, respectively). In a study performed by Plattner et al. in a total of 119 cases with SEH, causes of death were indicated as fatal blood loss associated with head (21 %) or chest trauma (18 %), fatal blood loss with (16 %) or without (18 %) head and chest trauma, natural causes (n = 3), hanging (n = 1), and heat stroke (n = 1), while only 8 % of the cases of death were related to isolated head traumas.[26] We think that the discrepancies between causes of death reported in our study and Plattner's study might stem from different methods of evaluation. In our study, due to insufficient data of crime scene investigation and medical information on traumatic fatal blood loss in our cases and also on their medical history, relevant assessments could not be achieved. Therefore, we thought that without sufficient necroptic evidence both about anemia, other hematological diseases, pathologies leading to chronic blood loss and also major vascular injuries, evaluations based only on macroscopic findings, such as pale body appearance, fail to yield accurate, and clear-cut results. It is obvious that evaluations made without gathering detailed information about traumatic blood loss on the crime scene, probable posttraumatic fluid replacements and blood transfusions applied for the treatment of the victim can not be a reliable and sound approach. In another study conducted by Harruf RC on 1034 forensic autopsies, the authors reported that SEH had been detected in 43 cases, apart from those exposed to direct cardiac trauma or those who underwent resuscitative interventions, and these victims were dead because of head trauma (60 %), intoxications (14 %), and abdominal trauma.[3] Though nearly an equal number of death cases related to isolated abdominal and head traumas were found in our study, in the established cases of SEH the most frequent cause of death was isolated abdominal trauma. In our study, only one case with SEH died of intoxication. On the other hand, cases directly exposed to chest trauma and resuscitated cases were not included in our study in order to discard direct traumatic cardiac effects on the pathogenesis of SEH, and disclose only influential extracardiac pathogenic mechanisms of SEH. However in a study performed by Bakkannavar et al., the authors indicated that in the established cases with SEH, traumatic deaths were caused most frequently by isolated head traumas, followed by multiregional body , extremity and abdominal traumas.[27] Among all causes of traumatic deaths, intoxications ranked second, and still different from the outcomes of this study, SEH had been reported in 20 burn injury cases.[27]

Plattner et al. indicated causes of death of 119 patients with SEH as traffic accidents (37.8 %), firearm injury (15.1 %), natural causes (11 %), penetrating wounds (6.7 %), fall from a height (3.4 %), and hanging (0.8 %).[26] However, in a study performed by Bakkannavar et al., traffic accidents took the lead among causes of death, followed by intoxications, fall from a height, and burn injuri-

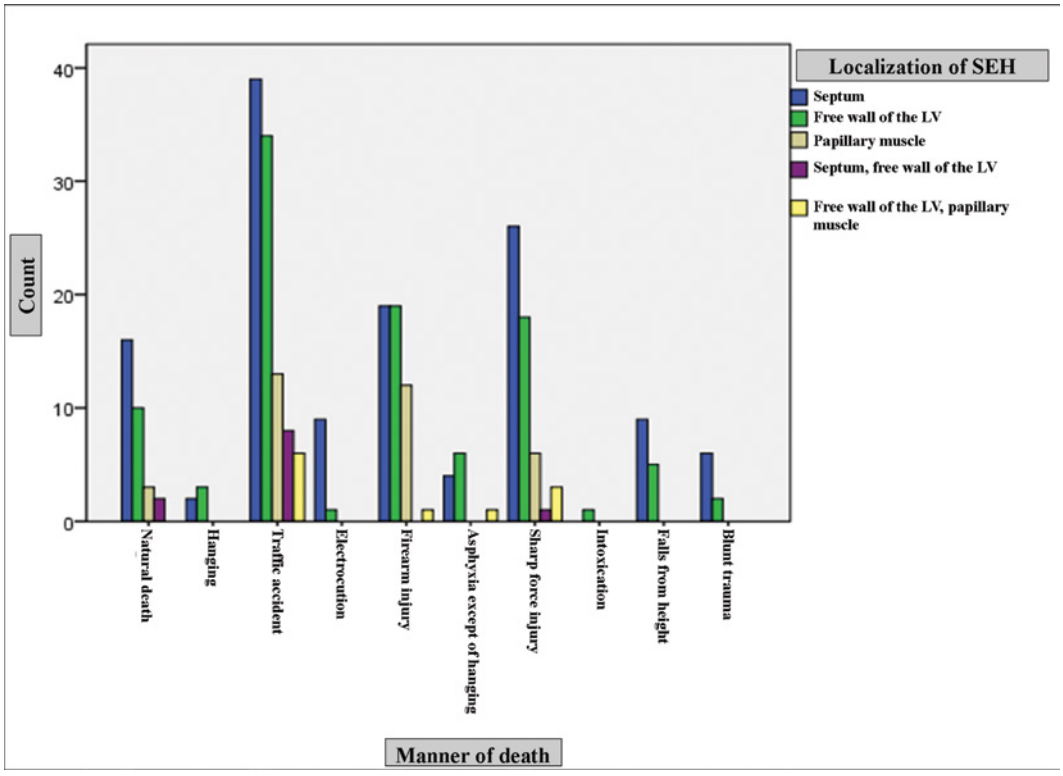

Figure 2: The distribution of cases according to the manner of death and localization of subendocardial hemorrhage (SEH).

es.[27] Outcomes of our study are generally in accordance with those of the Plattner et al.; only the rates of stab wounds in our study were found to be comparatively and significantly higher (18.9 %). On the other hand, in a study conducted by Bakkannavar et al., higher mortality rates were reported for intoxications and burn injuries in cases with SEH. We presumed that differences in other mortality rates were attributable to diversities in the number of cases included in various studies.

Accidents ranked first among the causes of death in cases with SEH, followed by ciriminal acts, murders and natural causes. In a study performed by Plattner et al.,[26] the causes of death were reported in the same order of frequency. However, mortality rates of accidents were lower, and of criminal acts were higher relative to our study, while suicidal, and natural death rates were comparable. In a study conducted by Bakkannavar et al., in 221 cases with SEH, accidents were on the top of the list (76.47 %), but the order of frequency of causes of death changed as follows: suicides (18.1 %), natural causes (3.62 %), and murders (18.1 %).[27]

SEHs have been reportedly localized on the upper part of the interventricular septum, contralateral side of the papillary muscles, the junction of trabeculae carneae on the left ventricular free wall. They have been also more conspicuously observed on the apical portion of the papillary muscle bundles of the left ventricle, AV bundle bifurcation of the septum, and regions in the vicinity of aortic annulus fibrosus *(2–5,25)*. In our study, in nearly half of the cases (45.6 %), SEH was most frequently localized on the interventricular septum, and in order of decreasing frequency on the free wall of the left ventricle (34.7 %), papillary muscles (11.9 %), interventricular septum and left ventricular free wall, (3.9 %), left ventricular free wall and papillary muscles (3.9 %). In a study by Bakkannavar et al., the authors reported the left ventricle as the most frequently seen location of SEH, while they also observed SEH in the right, and left atria and the left ventricle.[27]

In conclusion, first of all, these lesions should be accurately identified and defined by histopathological analyses in order to clarify their pathogenic mechanisms. However, miscellaneous underlying mechanisms and various causes of death detected in cases with these lesions suggest the presence of more than one underlying pathogenic me-

chanism. On the other hand, vitality evaluations, which are not cause-specific by nature, should be enlightened by further studies. Since these lesions are seen in a considerable number of necroptic examinations, further studies with accurate and clear-cut outcomes should be performed to reveal the supportive role of SEH in the clarification of causes of death, and their related pathogenic mechanisms.

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