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RESEARCH ARTICLE

AUTOPSY FINDINGS AND ELECTROLYTES CHANGES IN CASES OF DROWNING

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ABSTRACT

Background: Drowning is a main universal community health problem. In Medico- Legal practice the autopsy diagnosis of drowning presents one of the major problems especially when there is delay in recovering the victim from water. This study concentrates on gathering the autopsy findings with the electrolytes changes between the right and left ventricles to reach more accurate diagnosis of drowning. Objective: To determine the diagnostic features of drowning depending on the autopsy findings enforced by changes in electrolytes concenteration(Specially Chloride) between the right and left ventricle. **Methods:** This study was performed at Medico-legal Directorate (MLD) in Baghdad for (12) month' s within the period from 1/1/2018 - 31/12/2018. Full proper autopsy including external and internal examination of the body for all cases was performed, after obtaining complete medico-legal history, in addition to determination of Chloride levels difference between the blood of right and left venricle of the heart to determine the cause of the death as due to drowning. **Results:** The study included (60) cases, (52) male and (8) female with their ages ranged between (15-44years old) for male , while ages ranged between (1- 44years old) for females . Drowning is causes of death in all cases. Among the most important results of this study is the presence of froth around the nose and in air passage, emphysema quorum in almost all cases of drowning. there was a difference in the concentration of chloride between the right and left sides of the heart that difference is less than 25 mg /100ml. **Conclusion:** Drowning is the 10th cause of violent deaths in Baghdad. Corrugation and froth are the most common autopsy finding. Differnce in chloride concentration between the right and left ventricles adds an other important point in the diagnosis ogf drowning toghether with the autopsy findings.

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INTRODUCTION

Drowning is a main universal community health problem. It is the process of experiencing respiratory impairment from submersion / immersion in liquid as stated by WHO (Van, 2005; Joost, 2016) In Medico-Legal View drowning is a type of asphyxia due to aspiration of fluid either water, milk, oil ...etc instead of air and immersion of whole body or nose and \ or mouth under the level of fluid (Hussein Osman Salem, 1999; Hassan, 1980; Ali, 1976; Al-Jabri, 2000). In drowning there is relation between liquid and air junction at the entrance of the airway prevents breathing air (Idris, 2003). Drowning could be considered as a mixture of mechanical presence of water within the respiratory system (mechanical asphyxia) with liquid and electrolyte changes dependeding on the medium (either sea or fresh water) in which immersion has occurred (Simpson, 2011).

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Drowning cases are usually accidental in nature. They could be suicidal and rarely homicidal. Drowning is a common method of suicide in India and (35%) of cases in Austria are positive for alcohol. It is the second leading cause of accidental death in children at 14 years old It can happen in small plastic pools, bathtubs, and toilet bowls. Interpretations of the mechanism of drowning have undergone a radical changes during the (Second World War), when large numbers of seamen and airmen were exposed to the risks of drowning (Knight, 2004) In Medico-Legal Aspect the problems with drowning start with the scenes which are often uncontrolled, involving long sections of sea, rivers or lakeshore, mainly in cases underwater disaster identification (Winskog, 2012; Byard, 2008) and failure to find a body quickly may result in changes due to both purification and postmortem animal predation such as sea lice and sharks (Byard, 2002) Autopsy Signs include those of immersion and drowning signs. Immersion signs are Maceration (corrugation) of the skin which is the first sign that starts within minutes in warm water, for example in bathtub. In cold water it would be visible after a variable time, the minimum is (4 or 5) hours depending upon temperature but

Polson (1962) suggests a longer duration from (Winskog, 2012; Byard, 2008; Byard, 2002; Morelli, 2011; to 48) hours. Maceration is obvious in hands and soles, the skin becomes wrinkled, pale and wet so-called 'washerwoman's skin. Maceration could be seen also on the extensor surface of knees and elbows (Knight, 2004) Maceration may happen after some days in warmer water and up to several weeks in cold. The thick keratin of hands and feet becomes detached and eventually peels off in 'glove and stocking' fashion. The nails and hair become loosened at approximately the same time with difficulties of obtaining fingerprints in such situations. Maceration appears in summer days within (Zhang, 2017; Reijnen, 2017; Gotsmy, 2019; Fornes, 1998; Nakadate, 2012; Jian, 2019; Maeda, 2009; Takahashi, 2009; Pounder, 2005; Roll, 2004) minutes, in mild atmosphere in (Hussein Osman Salem, 1999; Hassan, 1980) hours and is delayed in cold season (Morelli, 2011). Cutis anserine (goose-flesh) is a common sign in immersed bodies but is connected to cold rather than warm water and cause a generalized pimpling of the skin. Rigor mortis can produce it (Knight, 2004). It is usual for most corpses to float or hang in water with buttocks uppermost, while the head and limbs are hanging down. The hypostasis of bodies pulled out cold water is frequently pink, this color is caused by the presence of unreduced oxyhemoglobin in the superficial blood vessels, but has no diagnostic value (Joost, 2016; Knight, 2004). Mud, coal-slurry, oil, silt or sand present on the body, in addition to other artefacts such as seaweed, waterweed, algae. Mud may be adherent to the whole-body surface and clothing. Sand may be found deep in the respiratory passages and stomach, especially if the body has been rolled by the waves on a beach. But deep penetration is not sign of live aspiration (Knight, 2004). The corpses are colder in the depths of rivers, seas, canals, and ponds than the ouer atmosphere. Contraction of scrotum may happen before or after death. Algae growth on the skin is helpful to determine the position of cadaver.

They may be found in trachea and stomach as asign of immersion, but not of active inhalation of fluid (Knight, 2004; Roll, 2004; Chalabi, 1978; Nandy, 1996). In Medico-legal practice, the autopsy diagnosis of drowning is one of the major problems specifically when there is delay in recovering the victim (Robert,; Stemberg, 2009) Drowning signs include froth in the air passages as a positive sign in fresh bodies. Froth is also seen around mouth and nostrils, sometimes in the form of a plume. Froth is edema fluid from the lungs and consists of a proteinaceous exudate and surfactant mixed with the water of the drowning medium (Hussein Osman Salem, 1999; Knight, 2004). It is white in color and may be pink or red-tinged, due to slight mixing up with blood from intrapulmonary bleeding (Knight, 2004; Morelli, 2011). Generally, the weights of a lung in drowning is about 600–700g, whilst the non drowned is about 370–540g. (Forens, 1998) Kringsholm -1991 cocluded that the duration of submersion is related to lung weight (Knight, 2004). Froth also observed in epilepsy, electrical shock, drug intoxication and cardiogenic pulmonary edema. Besides, this exudation is quite transient as it could be easily lost for a cardio-pulmonary resuscitation (Simpson, 2011; Forens, 1998) pitz and Fisher show at autopsy, the 5 lungs of a drowning victims commonly look like those seen in deaths associated with severe pulmonary edema, as in cases of arteriosclerotic heart disease (Robert, ; Lawler, 1992). The most important internal organ to observed and the most information about the cause of death in drowning are lungs. They are distended brick red in color, with signs of emphysema (Knight, 2004; Morelli, 2011; Hallery, 2003). The edema fluid in the bronchi locks the passive collapse that normally occurs at death, holding the lungs in the inspiratory position (Knight, 2004; Chalabi, 1978) , This is a positive sign of drowning at autopsy (Chalabi, 1978)

The increase in weight of lungs and is due to asphyxia and aspiration of water (Lawler, 1992). The heart and great veins are dilated and engorged with fluid blood, especially the right side, but this is non-specific (Morelli, 2011; Hallery, 2003; Modell, 1999). Pleural fluid accumulation Is associated with drowning, the volume of which controversially being said to reflect the postmortem interval (Simpson, 2011) Subpleural hemorrhages (Paultauf's spots) may reflect hemolysis within intra-alveolar spases and have been described in (50% – 60%) of cases of drownings. (Simpson, 2011; Modell, 1999) In Stomach there is wydlers sign due to swallowing of water or Mallory- Weiss syndrome (esophageal mucosal tear) (Lunetta, 2005). Miscellaneous signs in drowning include bloody or watery fluid in the intracranial sinuses, engorgement of solid organs, reduced weight of the spleen, Tardieu spot on organ and muscular hemorrhages in the neck and back and all are additional physical signs of drowning (Simpson, 2011). Cadaveric spasm is a positive sign and may be see in one or both hands. There may be grass, herbs, or gravel in the fist of the victim (Simpson, 2011; Knight, 2004; Chalabi, 1978; Nandy, 1996; Lawler, 1992). Chemical changes in the blood of drowning cases: Despite availability of modern imaging ,molecular tools, traditional autopsy, and laboratory finding remain golden standard for diagnosis of drowning (Brinkmann, 2004; Priyadarshini, 2004; Keil, 2014).

In Medic-legal practice there have been various attempts to use biochemical markers for determining the cause of death. Biochemical investigation may be helpful especially in difficult cases e.g. drowning, asphyxiation, poisoning (Zhu, 2002). Due to hemodilution that occurs in freshwater drowning and the electrolyte shifts in salt-water drowning, it is reasonable to expect the role of chemical analyses of the plasma to diagnose drowning. Getter -1921 analysed chloride content from the left and right sides of the heart, suggesting that the hemodilution from freshwater drowning would differentially reduce the plasma concentration on the left side, a difference of 25mg/100ml being significant. Salt-water drowning was said to produce the opposite effect (i.e. increase of chloride in blood in left side of heart 6 about (30% - 40%) because of concertation of blood. (Nandy, 1996). Durlacher -1953, he said no reliable changes in sodium, potassium and chloride concentration between freshwater and seawater drowning. (Keil, 2014). The aim of this study is to determine the diagnostic features of drowning depending on the autopsy findings enforced by changes in electrolytes concenteration (Specially Chloride) between the right and left ventricle.

Subjects and Methods

Site and Duration: Medico-legal Directorate (M.L.D.) of Baghdad for one year duration from 1\1\2018 till 31\12\2018.

Subjects: sixty victims of drowning.

Inclusion criteria: Cases with circumstantial evidence favoring drowning death.

Exclusion criteria: Decomposition.

Methods: External examination which include examination of clothes and extenal signs, followed by internal examination and taking blood samples for electorolytes testing, and this includes:

- Ten cc of blood to be taken from the right and left venticle of the heart.
- Samples to be left for 10-20 minutes to be cloted.
- Centrifugation at 300-400 RPM for 5-10 minutes.
- Taking the serum samples in test tubes and putting them in deep freezing at - 20 °c
- Samples tobe sent to the biochemistry lab for electrolytes investigation (Chloride, potassium, and sodium.)

Electrolytes investigation: Quantitative measurement of sodium, potassium and chloride ion concentration in serum.

Principle: Take 50 µL of serum is deposited on a FUJI DRI-CHEM SLIDE Na-KCl at the same time on the reference side and the sample side respectively. After depositing, the reference fluid and the sample spread along the distribution device and towards each other on the special thread bridge to form a stable ionic junction. A differential potential is generated between the two half-cells. The potential difference is proportional to the Loga-rhythm of each ion concentration ratio of the two fluids. The slide is incubated for a fixed time in the FUJI DRI-CHEM ANALYZER and the potentiometric difference between the reference and the sample is measured. The potentiometric value is then converted into each of the electrolyte's concentration using a calibration curve preinstalled in the analyzer.

Composition of the slide:

Multi-layered structure: Transparent support Ag layer AgCl layer Electrolyte layer Ion selective membrane Distribution device Reference Thread bridge fluid Patient sample Reference fluid Electrode terminal Sample Thread Bridge Multilayered film electrode Cl, k, Na Perdition materials. Ingredients per slide: Common to Na, K, CI. Silver 0.50 mg Silver chloride 0.26 mg NaCl 0.52 mg Methyl Monessen 0.31 mg NaCl 0.51 mg Valinomycin 0.14 mg Tri-alkyl ammonium chloride 0.95 mg

Procedure:

- Set slides on FUJI DRI-CHEM ANALYZER.
- Set a sample tube in the specified sample rack.
- Set the reference fluid in the specified position.
- Input a sequence No. and a sample ID .
- Press the "START" key to initiate testing. Normal range

Na 75 – 250 mmol/L
Cl 50 - 175 mmol/L
K 3.5 -5.5mmol/L

Total negative positive Corrugation 60 6 54 Photographs were taken to document the important findings. And finally the results were converted to tables and figures.

RESULTS

Throughout the period of study which extended from (1st) January to (31th) of December 2018, a total number of 6591 cases were referred to M.L.D. in Baghdad. Among that numer 134 cases were referred as drowning cases which constituted 2% of the total number and came 10th among different causes of death. Only 60 cases were included in the study which had had the inclusion criteria. Figure (1) showed that in (54=90%) of the cases, there were positive Corrugation of skin which is a sign of immersion. While in (6=10%) of the cases, corrugation was negative. An example of corrugation was captured and shown in photograph (1). The study showed that) 32 (approximately (53.3%) of cases were positive for Cutis anserina sign, as shown in Fig. (2). Photograph (2) shows this sign.

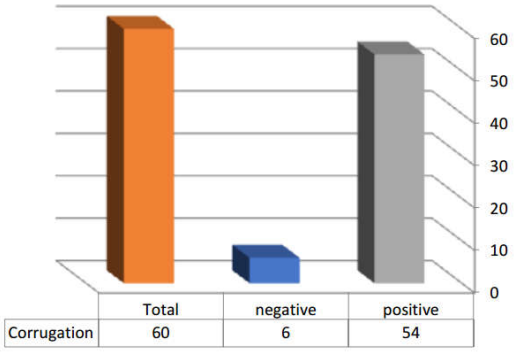


Fig. 1. Distribution of Corrugation of skin sign in drowning cases

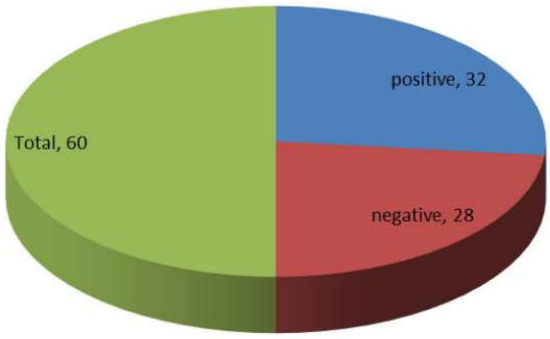


Fig. 2. Distribution of Cutis anserine sign in drowning cases

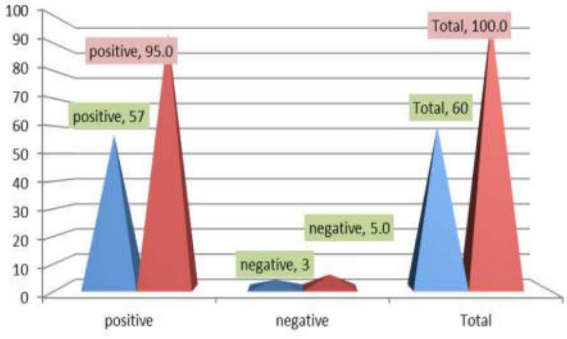


Fig. 3. Distribution of Froth around nose& in air passage sign in drowning cases

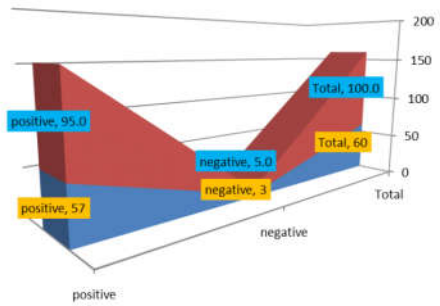


Fig. 4. Distribution of swallowing water sign in drowning cases

Table 1. Differece between RT side & LT side of heart chloride concentration in drowning cases

Rtside CI -------- Ltside CL /mg/100ml		
	5.39	Mean
1		Minimum
24		Maximum
	60	total

Photograph. 1. Maceration (corrugation) of the skin in the right foot in a case of drowning. Photo by a digital camera) NIKON – D7000)

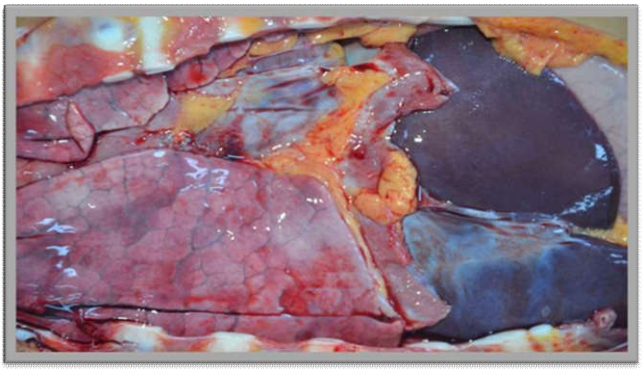
Photograph 2. Cutis anserina (goose-flesh) lateral aspect of thigh in a drowning case Photo by a digital camera) NIKON – D700)

Photograph 3. White froth around the nose in a child victim of drowning

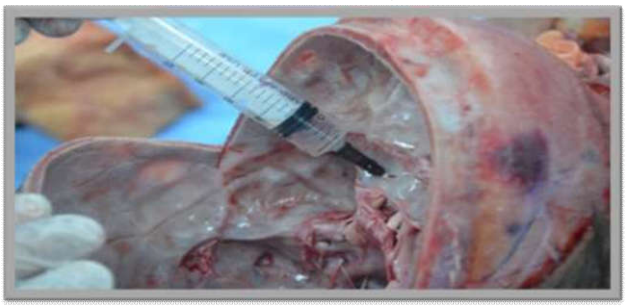
Photograph 4 & 5. Shows Mud adherent to the whole-body surface and clothing. Photo by a digital camera) NIKON – D700)

Photograph 6. Contraction of the scrotum with the genitals Photo by a digital camera) NIKON – D7000)

Photograph 7. stomach contain water in case no. 20 ,) wydlers sign): due to swallowing of water in drowning Photo by a digital camera) NIKON – D7000)



Photograph 8. Over Inflation of the lungs The lungs are brick red in color with impression of the ribs Photo by a digital camera) NIKON – D7000)



Photograph 9. Watery fluid aspirated from the sphenoidal sinus in a case of drowning. Photo by a digital camera) NIKON – D7000)

The study showed also that Froth around the nose (Photograph-3-) and in air passage was present in) 95% (equivalent to)57(of the cases of drowning as demonstrared in Fig. (3). Other external signs including Mud contamination (Photograph-4 & 5-) was present in (33) approximately (55%) of the cases. It was absent in (27) approximately (45%). contraction of scrotum (Photograph-6-) which appeared in)34) about (56.7% (of cases of drowning. While this sign was negative in (26=43.3%) of cases.During this study cadaveric spasm was not seen. It was is negative in all cases swallowing water was positive in (57=95%) of the cases, as shown in Fig. (4) and photograph (7). Among internal signs was the over inflation of lungs presented in almost all cases as shown in photograph (8). Other internal signs is aspiration of watery fluid from the sphenoidal sinus (Photograph-9-). The study showed that there was a difference in the concentration of chloride between the right and left sides of the heart where the lowest value for it was 1 mg/100ml. The highest value was 24 mg/100ml . Other details are shown in table (1):

DISCUSSION

The study showed that the number of deaths received by (M.L.D.) in Baghdad was (6591) cases during the period of the study. This large number is due to the fact that M.L.D. is the only medico-legal center in Baghdad. The number of cases referred as drowning cases were 134 but only 60 cases were included in the study due to putrefactive changes that had begun in the others. An Australian study found over the period 1992–1998 an average of 314 drowning death per year. (28) This difference from this study is due to difference in the community and the duration of the study. This study showed that most of the drowning cases showed the sign of Corrugation of skin because cadavers remains in the water for a long time may be more than 30 minutes or the water temperature is high.

While some cadavers did not show that sign because they pulled out from water shortly after drowning or due to low temprature of water. It's a sign of immersion because it is observed in women who use water for long time in the kitchen or bath.(29) The study showed that 32 cases of drowning showed cutis anserina sign of the skin due to water temperature was low during drowning and may be part of the rigors mortis that appear on the cadavers while other drowning cases did not show cutis anserina sign of the skin and that might be caused by the high temperature of the water or rigors mortis had not started or it had been finished. Both corrugation and cutis anserina are non specific for drowning. diagnosis of drowning is always one of the most difficult tasks in forensic pathology so pathologists should not depend only on the pathological signs, but in addition should perform laboratory examination, immunohistochemistry test and virtopsy technology (Zhang, 2017). The study showed that most drowning cases showed froth around the nose and in the respiratory tract. The reason that drowning was vital i.e. the person was alive inside the water and the froth is edema fluid from the lungs and consists of a proteinaceous exudate and surfactant mixed with the water from the drowning medium.

It is the opposite of immersion, while we have not seen it in some cases and the reason is due to the time of drowning is very short and the cadaver was pulled out shortly that the water that entered the lungs was very little. Froth can be seen in some deaths due to diseases such as heart disease This study agreed with study in Netherlands that most cases with the external froth present in fresh water drowning (Reijnen, 2017). The study showed that the sign of swallowing water was present in most cases of drowning and these cases are vital i.e. the victims were alive inside the water and swallowed water so it reached the stomach and lungs. Usually in cases of immersion under 4 meters, we get the sign of swallowing water reaching the stomac. While in cases where there's no water in the stomach, the reason may be in carrying the cadaver inverted with head down and legs above, this leads to the release of water through the mouth and nose out and when the autopsy would be performed, no water would be found in the stomach. This study agrees with study in Switzerland in forensic autopsy, the analysis of stomach contents is important when investigating drowning cases.

Three-layering of stomach contents may be interpreted as a diagnostic hint to drowning due to swallowing of larger amounts of water or other drowning media (Gotsmy, 2019). The study showed that (34) cases of drowning accompanied by scrotum contraction due to immersion in the water. It is considered part of the rigor mortis, or occurs before death due to low temprature of water. While the scrotum contraction was not seen due to a high temperature of water or at the end of the rigor's mortis. A study in Belgium also showed that scrotum contraction is a sign of immersion and not pathognomonic for drowning (Fornes, 1998). The study also showed that 55% of drowning cases were contaminated with mud in the body or clothes or both, because the cadaver was contaminated with mud inside water or as a result of being pulled on the ground while it was being pulled out from the water pools or swamps, mostly in rural areas and may be found deep in the respiratory passages and stomach, especially if the cadaver has been rolled by the waves on a beach. But deep penetration is not sign of live aspiration. While cases of drowning not contaminated with mud are likely to have occurred in regular and licensed swimming pools within the city.

This study agrees with study in Japan that showed 90% of victims died from drowning contaminated with mud, sand and a variety of microbes in their lower respiratory tracts (Nakadate, 2011). The study showed that the sign of cadaveric spasm was not present in any case. This sign is rather a rare sign. The important task of forensic identification is to distinguish between entering the water before and after death, and to clarify the cause of death. In the 18 practice of forensic identification, diagnosis of drowning is diagnosed based on autopsy signs, histopathological examinations, and diatom tests, with the exclusion of other causes of death. The virtopsy techniques provides new insights for the diagnosis of drowning (Roll, 2004). The study showed that there is a difference in the concentration of chloride between the right and left side of the heart where the lowest value was 1mg /100ml and the highest value was 24 mg /100ml, because in fresh water drowning a massive absorption of water through the alveolar membranes is about (70%) of the original blood volume within (Hussein Osman Salem, 1999) minutes lead to hemodilution of blood . This study agrees with study in Japan when there is a difference in the concentration of chloride between the right and left side of the heart. The mean of the left side of cardiac serum (Cl) levels were lower than right side in fresh water drowning (36). The study showed that the sign of fluidity of blood was positive in all cases of drowning and the reason is due to the increase release of fibrinolysin enzyme from the cells of the lining of the blood vessels damaged due to oxygen deficiency and is not considered a definite sign of drowning because it is observed in all cases of suffocation &in deaths resulting from electrocution and shock.

This study disagrees with that that had found large amounts of clots in drowning & other types of asphyxia. We adopted 0.1 mg/ml of blood ethanol concentration (BEC) as a cut off value, and a correlation of blood coagulability and BEC with blood clot was significantly higher in cases with positive BEC than those with negative BEC However. Based on this study, we considered that postmortem blood coagulability was influenced not only by simple pharmacodynamic actions of ethanol but also by other factors including coexisting pathological conditions (37). The study showed the presence of a sign of Tardieu spots in the viscera of all drowning cases and the reason is due to the expansion of the capillary blood vessels with stagnant blood in it with increased permeability and does not a definite sign of drowning because of its presence in cases of suffocation and electrocution and some natural deaths such as septicemia ,bacterial endocarditis . This study disagrees with study in France the Tardieu spots was described but has no diagnostic value for drowning . Most of the autopsy findings are related to asphyxia and have no specific link to drowning. (43)The study showed that the sign of the over inflation of the lungs in all cases of drowning because in the case of drowning water is entered in large quantities into the alveoli and leads to rupture of 19 alveoli and that the over inflation of the lungs is a confirm sign of drowning and fill thoracic cavity. This study agrees with a study in Belgium that found emphysema, edema, indentations of ribs in lungs, Paltauf's spots, froth in the trachea, elevated lung weights and pleural effusions in drowning case. (38)

Conclusion

Drowning was the (10^{th}) Cause of violent death being responsible for only (2%) of cases referred to M.L.D. in Baghdad during the period of study. Corrugation of skin and froth around the nose and in air passages are present in most of drowning cases. Contraction of scrotum, cutis anserina, and mud contamination were appeared in half of the cases. Also Cutis anserine sign showed in) 53.3% (of drowning cases. .The study showed that there is a difference in the concentration of chloride between the right and left sides of the heart below 25 mg /100ml. The study also showed Emphysema quorum of both lung, fluidity of blood and tardieu spot (positive) in (100%) of drowning cases.

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