



Sudden death and hydatid cyst: A medicolegal study

Sami Ben Jomaa^a, Nidhal Haj Salem^{a,*}, Imen Hmila^a, Said Saadi^a, Abir Aissaoui^b, Meriem Belhadj^a, Ali Chadly^a

^a Department of Forensic Medicine Teaching Hospital Fattouma Bourguiba of Monastir, Tunisia

^b Department of Forensic Medicine Teaching Hospital Taher Sfar of Mahdia, Tunisia

ARTICLE INFO

Keywords:

Hydatid cyst
Sudden death
Anaphylaxis
Forensic medicine

ABSTRACT

The discovery of a hydatid cyst at autopsy poses the problem of its involvement in the mechanism of death.

The aim of this study is to analyse the epidemiological and etiopathogenic characteristics of death attributed to hydatid disease, to discuss the mechanism of death and to propose preventive measures.

This is a retrospective descriptive study of 26 cases of death with hydatid cyst autopsic discovered, collected at the forensic department of Fattouma Bourguiba University Hospital of Monastir (Tunisia) over a period of 27 years (from 1990 until 2017).

In 26 cases, hydatid cyst was observed during autopsy of sudden death cases, which corresponds to 0.33% of the total of autopsies in this period. Of the 26 victims, 13 (50%) were men; the mean age was 43 years.

Most victims were from rural zones (18 cases).

In 20 cases, the complicated cyst was hepatic. It was cardiac in two cases. Of all cases, three cysts were cracked, and nine were broken. Of the 26 cases, only 15 were implicated in the death mechanism. Death was attributed to anaphylaxis in 12 cases, hydatid pulmonary embolism in 1 case, cardiac arrhythmia in one case and hemothorax in one case.

Sudden death is the most dangerous complication of the hydatid cyst which can be discovered at autopsy. Several causes may explain its occurrence, the most common of which is anaphylactic shock.

1. Introduction

Echinococcosis, also known as hydatid disease, is a human infection that is caused by the larval stage of *Echinococcus granulosus*. It is a parasite disease which is common in several regions of the world, e.g., the Mediterranean countries, the Middle East, South America, East Africa, as well as some areas in Canada and Australia [1]. In Tunisia, Hydatidosis is an endemic disease as the annual average incidence within the general population is estimated to be 1.67 cases per 100.000 inhabitants per year (Ministry of Public Health, unpublished data). This infection is characterized by its high clinical latency. Patients are generally asymptomatic during long periods [2,3]. The natural history of the disease can be enameled by several complications. Sudden death is the most dreadful one. The discovery of a hydatid cyst at autopsy poses the problem of its involvement in the mechanism of death. The role of the hydatid cyst in the mechanism of death is sometimes difficult to determine, especially in the presence of a macroscopically intact cyst. In fact, the presence of microcracking, which is highlighted by the histologic exam, can implicate the cyst in the mechanism of death

especially when no other cause of the death is found.

The aim of this study is to analyse the epidemiological and etiopathogenic characteristics of death attributed to hydatid disease and to discuss the mechanism of death.

2. Materials and methods

This is a retrospective descriptive study of 26 cases of death with hydatid cyst autopsic discovered, collected at the forensic department of Fattouma Bourguiba University Hospital of Monastir (Tunisia) over a period of 27 years (from 1990 until 2017).

A data collection sheet was used based on deceased's families, judicial investigation data, external body examinations and autopsies. In each case, we have studied the following variables:

- Epidemiological criteria: age, sex, origin, medical history
- Death circumstances: time, place, triggering factor, prodromal symptoms.
- External examination of corpse and autopsy observations. The

* Corresponding author at: Department of Forensic Medicine Teaching Hospital Fattouma Bourguiba of Monastir, 5000, Tunisia.

E-mail address: nidhal.hajsalem@yahoo.fr (N. Haj Salem).

<https://doi.org/10.1016/j.legalmed.2019.07.001>

Received 16 January 2019; Received in revised form 21 June 2019; Accepted 4 July 2019

Available online 05 July 2019

1344-6223/ © 2019 Elsevier B.V. All rights reserved.

autopsy was complete and the brain was examined as the other organs systematically.

- Results of toxicology screening included research of drug principles (salicylates, tricyclic antidepressants, phenothiazines, benzodiazepines and paracetamol) pesticide substances (organophosphorus, carbamate, chloralose), methanol and ethanol, cannabis, cocaine and heroin).
- Results of histology examination of samples taken for heart (left ventricle, right ventricle, septum and coronary arteries) liver, lungs (left and right), kidneys (left and right), spleen, pancreas, cerebellar tissue, brain tissue, hydatid cyst and any other suspect lesion. Stain used for this exam is Haematoxylin and Eosin.
- Death mechanism.

Data were analyzed using SPSS for Windows (version 20.0; SPSS Inc, Chicago, Ill) and are presented as numbers, percentages, and means.

3. Results

3.1. Cases characteristics

During the study period, we performed a total of 7808 autopsies. In 26 cases, hydatid cyst was observed during autopsy of sudden death cases, which corresponds to 0.33% of the total of autopsies in this period.

Of the 26 victims, 13 (50%) were men. The mean age was 43 years. Most victims were from rural zones (18 cases). The majority of victims were jobless (nine cases) and in seven cases were farmers. A summary of cases characteristics is shown in Table 1.

3.2. Death circumstances

Of the 26 cases, only 17 presented prodromal symptoms. The most frequently found were faintness ($n = 8$) and abdominal pain ($n = 5$). In 14 cases, the place of death was the victim house, and in 10 cases, death had occurred at the hospital. Death was spontaneously in 21 cases, and trauma was the triggering factor in only four cases. A summary of death circumstances is shown in Table 1.

3.3. Autopsy findings

In 20 cases, the complicated cyst was hepatic (Figs. 1–3). It was cardiac in two cases (Fig. 4). Of all cases, three cysts were cracked, and nine were broken. The content of the cyst was clear in 13 cases, hemorrhagic in four cases, and infected in three cases. Cyst content was

Table 1
Summary of case characteristics.

Age, mean	43 (21.3)
Incidence	0.33
Sex ($n = 26$)	
Female	13
Male	13
Sex ratio	1
Origin region ($n = 26$)	
Rural	18
Urban	8
Hydatid disease history ($n = 26$)	
Yes	3
No	23
Professional status ($n = 26$)	
Without occupation	9
Farmer	7
Builder	5
Female factory worker	3
Student	1
Sheet Metal Worker	1



Fig. 1. Residual cavity of a hydatid cyst located in the liver.

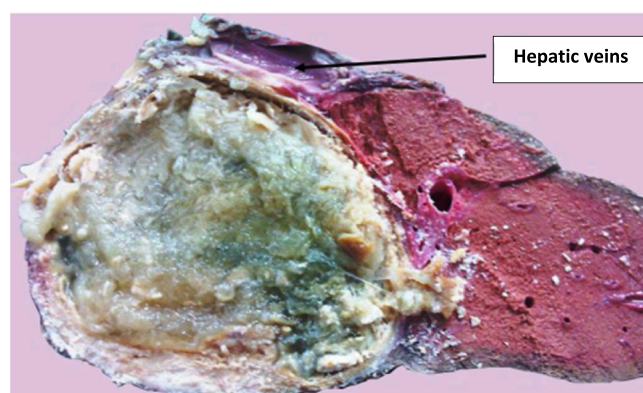


Fig. 2. Hydatid cyst located in the liver in contact with the left hepatic veins.

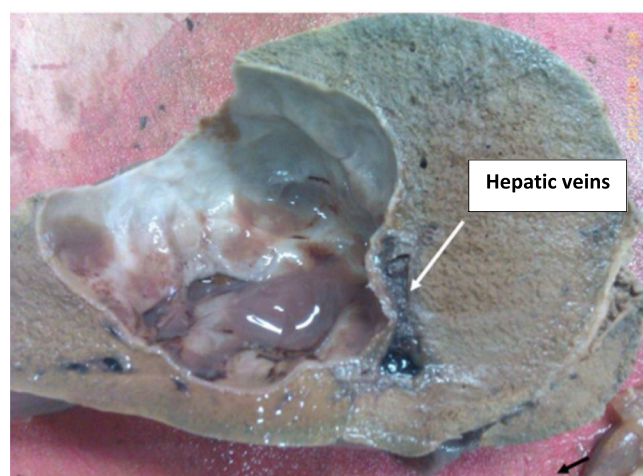


Fig. 3. Residual cavity of an hydatid cyst in contact with the left hepatic veins.

discharged into vessels in five cases, into bile ducts in four cases, into the peritoneal cavity in two cases, into the right ventricle in one case, into the bronchi in one case and into the pleural cavity in one case. A summary of the autopsy findings is shown in Table 2.



Fig. 4. Hydatid cyst located in the Right Ventricle.

Table 2
Summary of autopsy findings.

Cyst size (cm), mean	7.3 (5.97)
Cyst localization (n = 26)	
Liver	20
Heart	2
Spleen	1
Aorta	1
Multiple	2
Complicated cyst wall (n = 26)	
Intact	14
Cracked	3
Broken	9
Cyst rupture place (n = 14)	
Vessels	5
Bile ducts	4
Peritoneal cavity	2
Pleural cavity	1
Bronchi	1
Right ventricle	1
Complicated cyst contents (n = 26)	
Clear	13
Infected	3
Hemorrhagic	4
Calcified	6

3.4. Complementary examination result

Toxicological examinations were negative in all cases. Histological examinations confirmed the hydatid nature of the cyst in all cases of our series. A summary of the autopsy findings is shown in Table 3.

3.5. Death mechanism

Of the 26 cases, only 15 were implicated in the death mechanism. Death was attributed to anaphylaxis in 12 cases, hydatid pulmonary embolism in one case, cardiac arrhythmia in one case and hemothorax in one case. A summary of the autopsy findings is shown in Table 4.

4. Discussion

This is a retrospective descriptive study conducted in the forensic department of Fattouma Bourguiba University Hospital of Monastir (Tunisia). We performed a total of 7808 autopsies over a period of

Table 4
Implication of cyst in the death mechanism.

Not implicated	11
Implicated (n = 15)	
Anaphylaxis	12
Hydatid pulmonary embolism	1
Cardiac arrhythmia	1
Hemothorax	1

27 years (from 1990 until 2017). During this period, hydatid cysts were observed during autopsy of sudden death in 26 cases, which corresponds to 0.33% of the total of autopsies in this period. A Tunisian study performed in the Forensic Medicine Department of the Charles Nicolle Hospital (Tunis) found that sudden death due to hydatid cyst represents 0.3% of the total of autopsies and 1.1% of the natural deaths autopsied in the period of study [4]. Another Tunisian study established in the forensic medicine departments of Farhat Hached Hospital (Sousse) and Kasserine Regional Hospital reported that the incidence of sudden death due to hydatid during the period of study is 1.3% [5].

Human echinococcosis is a parasitic infection which is most commonly caused by larval stage of echinococcosis granulosis, for which dogs are definitive hosts. Humans may become accidentally intermediate hosts. He can be infested by the parasite's free eggs either by ingesting contaminated vegetables and/or water, or by a direct contact with infected dogs [2,3,6,7]. Echinococcosis is a cosmopolitan zoonosis distributed unequally over the different regions of the globe with areas of high endemicity such as the Middle East, Australia, South America, southeastern Africa, in some states of the United States, China and in Mediterranean countries (Maghreb, Greece, Turkey) [8,9]. In Tunisia, this affection is endemic and the annual incidence rate is constant at around 15 per 100,000 inhabitants [5].

Echinococcosis can be seen at any age. However, this affection prevailed at a young age between 21 and 40 years [10]. In our series, the mean age of our patients was 43 years with extreme ranging from 8 to 80 years which is consistent with data from the literature. This predominance can be explained by the slow evolution of cyst which can take place during childhood and can only be expressed in adulthood.

In children, hydatid cyst infestation is more common in boys than girls. This predominance can be explained by two hypotheses. First of all boys always take care of herds that is why they are more susceptible to exposure to dogs than girls [11]. Secondary, the growth rate of the cyst might be influenced by the host sex. Cyst growth would be slower in the female, which would delay the clinical expression of the disease until adulthood. Moreover, in adults, women predominance of hydatid cyst infection is noted [12]. According to some authors, this may also be related to the effects of sex hormones on the immune response and the development of parasitic infections [11,13].

Literature observations show that sudden death due to hydatid cyst was more frequent among males. This predominance can be related by the occurrence of minimal trauma (fall) as a factor in cyst rupture, which is most common in males [14]. In our study, equality of hydatid cyst infection between the two sexes was found with a sex ratio of 1.

Hydatid disease is more common in rural areas [15–17]. This is the result of the parasite cycle, and thus the presence of the final, accidental and intermediate hosts. Animal infection rates are perfectly parallel to the high rates of surgical incidence of hydatid cyst in humans [15,16,18].

Several authors report cases of sudden death by hydatid cyst in patients living in the countryside, with presence of sheep and dogs in the surroundings [1,14,19]. In our study, most victims were from rural zones (18 cases). However, the disease can also affect urban zone, linked to an incomplete cycle: parasitic viscera-dog-man, favored by the illegal slaughter of sheep and thus the easy access of dogs to contaminated waste [17].

In the literature, most cases of hydatid cyst are described in

Table 3
Histological findings.

Pulmonary congestion	6
Pulmonary edema	5
Laryngeal edema	2
Emphysema	1
Spleen congestion	1
Myocardial lipomatosis	1

agricultural workers [20,21]. This is related to the presence and proximity of dogs and sheep around. In our study victims were farmers in seven cases.

Sudden and unexpected death may be the first and ultimate cyst manifestation. In the literature cases, sudden death due to hydatid cyst is preceded in the majority of cases by prodromal symptoms. However, these symptoms are inconstant, nonspecific, and variable [22]. Prodromal symptoms are variable and depend on location of the cysts, size and evolutive stage (complications) [22–26]. In the literature cases, the most reported symptoms are dyspnea, thoracic pain, cough, weakness, skin eruption and digestive disorders (abdominal pain, vomiting) [27–29].

Hydatid cyst is commonly located in liver (55–70%) and lungs (18–35%) [30]. Among the other involved organs are brain, heart, kidneys, spleen, uterus, muscle, and bones. This predominance is explained by parasite cycle. However, ingestion of eggs by intermediate host animals or humans results in the release of an oncosphere into the gastrointestinal tract which then migrates to primary target organs such as liver and lungs, and less frequently to other organs [31]. In our study Hydatid cyst has a hepatic localization in 20 cases.

Cardiac involvement by echinococcosis at any age is very rare and occurs in 0.5–3% of the cases. This location presents 7% of the cases in our series. This relatively high rate could be explained by the severity of the hydatid cyst of the heart and its fatal complications.

The cysts usually grow slowly. The size growth differs from one cyst to another, one organ to another and one patient to another [23]. The hydatid cyst can grow to a very large size, which increases the risk of complications [32]. These large cysts (> 10 cm in literature [33]) are easily exposed to rupture because they are more accessible to trauma and are the seat of intracystic pressure [34].

In our study, 12 cases of cysts were ruptured. Hydatid cyst rupture may be classified into 3 types: contained rupture, when only the endocyst is torn and the cyst contents are confined within the pericyst. Communicating rupture, which consists of tear of the endocyst with a loss of the cyst contents via biliary radicles that have been incorporated in the pericyst. Direct rupture, when a tear of both endocyst and pericyst occurs, allowing the cyst contents to spill into the peritoneal or pleural cavities [35,36].

Increased cyst diameter, which increases the internal tension, and superficial location of the cyst are important risk factors for rupture, even with minor trauma [37,38].

The discovery of a hydatid cyst at autopsy can pose a problem of its implication in the mechanism of death. In our study, only 15 cysts were implicated in the death mechanism. In those cases, death was attributed to anaphylaxis in 12 cases, hydatid pulmonary embolism in one case, cardiac arrhythmia in one case and hemothorax in one case. Postmortem diagnosis of anaphylaxis is difficult. Indeed, there is no specific sign to affirm with certainty that anaphylaxis is the cause of death.

Anaphylaxis is due to leakage of the highly antigenic cyst fluid contained hydatid scolices in blood vessels or in anatomic cavities [6,39]. This can be secondary to a macroscopic or a microscopic rupture of the cyst [40]. Rupture may be precipitated by relatively minor chest or abdominal trauma or by increased pressure within the cyst and tends to involve cysts within the liver and less often the heart [41,42]. Cyst rupture into the peritoneal cavity can be occurred in 1 to 8% of contaminated individuals. This may train to rapid death by anaphylaxis or delayed death by sepsis and multiorgan failure [42].

At autopsy, cyst can appear macroscopically intact or even ruptured and depressed. The site of cyst rupture should be verified measurement of serum specific IgE levels and tryptase should be undertaken, as with all cases of suspected fatal anaphylaxis [43]. Measurements of chymase have been used in postmortem diagnosis of acute anaphylaxis [44].

In the literature, many cases of anaphylaxis have been reported without any flagrant macroscopic sign of cyst rupture [45]. At autopsy most commonly observed signs related to anaphylaxis were pulmonary congestion, intra-alveolar haemorrhage, upper airway edema,

bronchial hypersecretion and laryngeal and/or pharyngeal edema [44]. Other signs can be also observed and must be sought which caused by cerebral hypoxia in delayed death as cerebral edema, skin eruption and polyvisceral congestion [44,46].

Pathological examination of different organs may help to make post-mortem diagnosis of the anaphylaxis. The lungs may be the seat of significant emphysema. Microscopic examination of the bronchi may reveal bronchial lumen secretions, *peri*-bronchial congestion, mucosal edema, epithelial desquamation and eosinophilic infiltration.

In our study, diagnosis of fatal anaphylaxis was founded on ante-mortem signs, autopsy findings, and histologic finding. It was based on clusters of arguments because there is no specific signs on autopsy that can confirm the anaphylaxis which is considered as eliminated diagnosis.

Anaphylaxis was suspected regarding to:

- Circumstances of death such as abdominal pain, which can be considered as sign of rupture or cracking of the cyst.
- Autopsy finding such as laryngeal edema and cracked or broken cyst.
- Histological finding (pharyngo-laryngeal edema).
- The absence of any other cause of death.

All of these arguments were used to attribute the death to anaphylaxis in our study.

We were not able to perform the IgE and Tryptase blood rate as it could not be performed in Tunisia for postmortem samples. Besides our study is retrospective and this is one of the principle limit.

One of the other complications leading to death are embolus. Pulmonary embolic is due to right ventricular hydatid cyst which is complicated by fissuration or rupture. The extent of intracardiac cyst rupture is significant. Rupture may be large enough to release daughter cysts and cause vesicular embolism. Whereas, metastatic visceral echinococcosis may result if a patient overcomes acute phase of tiny ruptures.

In our study, death due to hydatid pulmonary embolism is reported in one case. In this case pulmonary embolism is secondary to breaking of inter ventricular septum hydatid cyst into the pulmonary artery.

Cardiac hydatidosis is rare (0.5% of total localization) [26,47]. Cysts may be found in all parts of the heart, but they are more prevalent in the left ventricle because of its rich vascularization and its thickness [22,26,47].

In our study, three patients had presented a heart cyst. The cyst sits in the right ventricle in two cases and in the inter-ventricular septum in one case. One patient in our study had presented a hydatid cyst in the thoracic aorta.

Many fatal complications specific to this localization may occur such as cardiac tamponade and pericarditis by rupture of cysts into the pericardial sac, conduction disturbances and arrhythmias secondary to compression of conduction tissue and coronary artery compression leading to myocardial infarction [1,39,48–50].

In our study, death was due to cardiac arrhythmias complicating a hydatid cyst of the right ventricle is reported in one case, anaphylaxis shock in one case (multi-organ hydatosis) and hydatid pulmonary embolism in one case. In one case, a patient died by hemothorax after rupture of a false hydatious aneurysm of the aorta.

Other hydatid cyst localizations are reported, however it remains exceptional. hydatid cyst can be found in the brain, kidneys, spleen, uterus, muscle, and bones. Complications are possible. They depend on size and location. Sudden death may follow especially when these cysts rupture through an anaphylactic shock.

5. Conclusion

Hydatid disease may remain asymptomatic. The liver localization is the most common one. When we find a hydatid cyst at autopsy, his

implication in the death is not in all cases certain especially when death is attribute to anaphylaxis.

Declaration of interest

The authors declare that they have no conflict of interest.

References

- [1] V. Malamou-Mitsi, L. Pappa, T. Vougiouklakis, D. Peschos, N. Kazakos, G. Grekas, et al., Sudden death due to an unrecognized cardiac hydatid cyst, *J. Forensic Sci.* 47 (5) (2002) 1062–1064.
- [2] R.W. Byard, An analysis of possible mechanisms of unexpected death occurring in hydatid disease (echinococcosis), *J. Forensic Sci.* 54 (4) (2009) 919–922.
- [3] N. Khanfar, Hydatid disease: a review and update, *Curr. Anaesth. Crit. Care* 15 (3) (2004) 173–183.
- [4] M. Ben Khelil, M. Allouche, A. Banasr, F. Gloulou, A. Benzarti, M. Zhioua, et al., Sudden death due to hydatid disease: a six-year study in the northern part of Tunisia, *J. Forensic Sci.* 58 (5) (2013) 1163–1170.
- [5] M. Jedidi, S. Mlayeh, T. Masmoudi, M.K. Souguir, M. Zemni, Sudden death due to hydatid cyst: thirty-four medicolegal autopsy cases, *Am. J. Forensic Med. Pathol.* 35 (1) (2014) 29–33.
- [6] S. Georgiou, J. Maroulis, A. Monastirli, E. Pasmatzis, D. Pavlidou, D. Karavias, et al., Anaphylactic shock as the only clinical manifestation of hepatic hydatid disease, *Int. J. Dermatol.* 44 (3) (2005) 233–235.
- [7] Y. Büyükc, A.A. Turan, I. Üzünc, Y. Aybar, Ö. Cinc, G. Kurnaz, Non-ruptured hydatid cyst can lead to death by spread of cyst content into bloodstream: an autopsy case, *Eur. J. Gastroenterol. Hepatol.* 17 (6) (2005) 671–673.
- [8] P.R. Torgerson, Economic effects of echinococcosis, *Acta Trop.* 85 (2003) 113–118.
- [9] C. Dziri, K. Haouet, A. Fingerhut, Treatment of hydatid cyst of the liver: where is the evidence? *World J. Surg.* 28 (2004) 731–736.
- [10] D.P. McManus, W. Zhang, J. Li, P.B. Bartley, Echinococcosis, *Lancet* 362 (2003) 1295–1304.
- [11] K.M. Al-Qaoud, P.S. Craig, S.K. Abdel-Hafez, Retrospective surgical incidence and case distribution of cystic echinococcosis in Jordan between 1994 and 2000, *Acta Trop.* 87 (2) (2003) 207–214.
- [12] T. Carmoi, P. Farthouat, X. Nicolas, J.-M. Debonne, F. Klotz, Kystes hydatiques du foie, *EMC – Hépatol.* 3 (2) (2008) 1–18.
- [13] S.L. Klein, Hormonal and immunological mechanisms mediating sex differences in parasite infection, *Parasite Immunol.* 26 (6–7) (2004) 247–264.
- [14] A. Hassine, Mort subite par kyste hydatique dans le centre tunisien : à propos de 34. [Thèse de doctorat en médecine], Université de Sousse Faculté de Médecine, 2010.
- [15] K. Aoun, A. Bouratbine, Actualités épidémiologiques de l'hydatidose en Tunisie, *Med. Mal. Infect.* 37 (2007).
- [16] M. Ben Abid, M.K. Chahed, R. Noura, Y. Galai, A. Bouratbine, K. Aoun, Connaissances, comportements et implications sur la transmission de l'hydatidose en Tunisie, *Knowl. Behav. Implications Hydatidosis* 1 (4) (2009) 22–28.
- [17] M. Besbes, F. Sellami, F. Cheikhrouhou, F. Makni, A. Ayadi, L'abattage clandestin en Tunisie: enquête sur les connaissances et les pratiques des bouchers face à l'hydatidose, *Bull. la Société Pathol. Exot.* 96 (4) (2003) 320–322.
- [18] Ministère de la santé publique : incidence chirurgicale de l'hydatidose en Tunisie 1988–1990 (page consulté le 16/02/2018). Rapport de la direction de la santé et des soins de base 1993 Tunisie [en ligne]. <http://www.santetunisie.rns.tn/fr/>.
- [19] S. Demirci, G. Gunaydin, K.H. Dogan, H. Toy, Sudden death due to hydatid cyst rupture located in right ventricle, *Am. J. Forensic Med. Pathol.* 29 (4) (2008) 346–348.
- [20] M.A.M. Mokhtari, A. Spoutin, Splenic hydatid cyst and relevation with anaphylaxis, *Res. J. Med. Sci.* 2 (5) (2008) 248–250.
- [21] A.K. Uzunlar, F. Yilmaz, M. Bitiren, Echinococcosismultilocularis in south-eastern Anatolia, Turkey, *East Afr. Med. J.* 80 (8) (2003) 395–397.
- [22] A. Aissaoui, N. Haj Salem, A. Chadly, Mort subite par l'hydatidose cardiaque, *Journal de médecine légale droit médical.* 53 (4) (2010) 407–410.
- [23] J. Eckert, P. Deplazes, Biological, epidemiological, and clinical aspects of echinococcosis, a zoonosis of increasing concern. Vol. 17, *Clin. Microbiol. Rev.* (2004) 107–135.
- [24] M.T. Goncu, S. Yavuz, M.C. Basel, I.A. Ozdemir, Left ventricular hydatid cyst causing acute pericardial tamponade without rupture, *Indian J. Thorac. Cardiovasc. Surg.* 20 (2) (2004) 95–97.
- [25] K. Karakaya, Spontaneous rupture of a hepatic hydatid cyst into the peritoneum causing only mild abdominal pain: a case report, *World J. Gastroenterol.* 13 (5) (2007) 806–808.
- [26] M. Kosecik, M. Karaoglanoglu, B. Yamak, Pericardial hydatid cyst presenting with cardiac tamponade, *Can. J. Cardiol.* 22 (2) (2006) 145–147.
- [27] A. Chadly, S. Krimi, T. Mghirbi, Cardiac hydatid cyst rupture as cause of death, *Am. J. Forensic Med. Pathol.* 25 (2004) 262–264.
- [28] N.E. Aydin, E. Ege, M.A. Selçuk, et al., Echinococcal hydatid cyst at the right ventricle outlet with leakage to the pulmonary artery outflow causing follicular airway disease and sudden death, *Am. J. Forensic Med. Pathol.* 22 (2001) 165–168.
- [29] Y. Buyuka, A.A. Turan, I. Uzun, et al., Non-ruptured hydatid cyst can lead to death by spread of cyst content into bloodstream: an autopsy case, *Eur. J. Gastroenterol. Hepatol.* 17 (2005) 671–673.
- [30] C. Col, M. Col, H. Lafci, Unusual localizations of hydatid disease, *Acta Med. Austriaca* 30 (2003) 61–64.
- [31] B. Gottstein, Hydatid disease, in: J. Cohen, W.G. Powderly (Eds.), *Infectious Diseases*, 2nd ed., Mosby, London, 2004, pp. 1601–1606.
- [32] J. Sakhr, A. Ben Ali, Le kyste hydatique du foie, *J. Chir.* (2004) 381–389.
- [33] G. Ozturk, B. Aydinli, M.I. Yildiran, M. Basoglu, S.S. Atamanalp, K.Y. Polat, et al., Posttraumatic free intraperitoneal rupture of liver cystic echinococcosis: a case series and review of literature, *Am. J. Surg.* 194 (3) (2007) 313–316.
- [34] T. Piskin, C. Ara, A. Dirican, D. Ozgor, B. Unal, S. Yilmaz, Perforated hydatid cyst into peritoneum presented with urticaria: a case report, *Dicle tip Derg./Dicle Med. J. Cilt.* 37 (2010) 71–74.
- [35] S. Avcu, Ö. Ünal, H. Arslan, Intrabiliary rupture of liver hydatid cyst: a case report and review of the literature, *Cases J.* 10 (2) (2009) 6455.
- [36] P.J. Marriott, J. Karani, S.B. Lucas, et al., Anaphylaxis from intravascular rupture of hydatid disease following liver trauma, *J. Surg. Case Rep.* 7 (2010) 1–5.
- [37] A. Dirican, M. Yilmaz, B. Unal, F. Tatli, T. Piskin, C. Kayaalp, Ruptured hydatid cysts into the peritoneum: a case series, *Eur. J. Trauma Emerg. Surg.* 36 (4) (2010) 375–379.
- [38] C. Feleppa, L. D'Ambra, S. Berti, P. Magistrelli, C. Sani, E. Falco, Laparoscopic treatment of traumatic rupture of hydatid hepatic cyst—is it feasible? a case report, *Surg. Laparosc. Endosc. Percutan Tech.* 19 (4) (2009) e140–e142.
- [39] I. Pakis, E.U. Akyildiz, F. Karayel, A.A. Turan, B. Senel, M. Ozbay, et al., Sudden death due to an unrecognized cardiac hydatid cyst: three medico-legal autopsy cases, *J. Forensic Sci.* 51 (2006) 400–402.
- [40] B. Sanei, S.M. Hashemi, M. Mahmoudieh, Anaphylactic shock caused by non-ruptured hydatid cyst of the liver, *J. Gastrointest. Surg.* 12 (2008) 2243–2245.
- [41] P.G. Meyer, C. Bonneville, G.A. Orliaguet, P. Dessemme, P. Blakime, P.A. Carli, et al., Grand mal seizures: an unusual and puzzling primary presentation of ruptured hepatic hydatid cyst, *Paediatr. Anaesth.* 16 (2006) 676–679.
- [42] H. Derici, T. Tansug, E. Reyhan, A.D. Bozdog, O. Nazli, Acute intraperitoneal rupture of hydatid cysts, *World J. Surg.* 30 (2006) 1879–1883.
- [43] K.J. Riches, R.W. Byard, The detection of fatal anaphylaxis at autopsy—an overview, *Scand. J. Forensic Sci.* 10 (2004) 61–63.
- [44] N. Trani, L.R. Bonetti, G. Gualandri, G. Barbolini, Immediate anaphylactic death following antibiotics injection: splenic eosinophilia easily revealed by pagoda red stain, *Forensic Sci. Int.* 181 (1–3) (2008) 21–25.
- [45] A. Gelincik, F. Ozşeker, S. Büyükcöztürk, B. Colakoglu, M. Dal, A. Alper, Recurrent anaphylaxis due to non-ruptured hepatic hydatid cysts, *Int. Arch. Allergy Immunol.* 143 (4) (2007) 296–298.
- [46] M. Shameem, R. Bhargava, Z. Ahmad, N. Fatima, N. Nazir Shah, Mediastinal hydatid cyst rupturing into the pleural cavity associated with pneumothorax: case report and review of the literature, *Can. Respir. J.* 13 (2006) 211–213.
- [47] G. Orhan, B. Ozay, Z. Tartan, E. Kurc, B. Ketenci, M. Sargin, et al., Chirurgie des kystes hydatiques cardiaques. Trente-neuf ans d'expérience, *Ann. Cardiol. Angeiol. (Paris)* 57 (1) (2008) 58–61.
- [48] I. Pakis, E.U. Akyildiz, F. Karayel, et al., Sudden death due to an unrecognized cardiac hydatid cyst: three medicolegal autopsy cases, *J. Forensic Sci.* 51 (2006) 400–402.
- [49] V.M. Malamou-Mitsi, L. Papa, T. Vougiouklakis, et al., Sudden death due to an unrecognized cardiac hydatid cyst, *J. Forensic Sci.* 47 (2002) 1062–1064.
- [50] M. Ileri, I. Hisar, R. Atak, et al., A pericardial hydatid cyst masquerading as acute inferolateral myocardial infarction: a case report, *Angiology* 56 (2005) 637–640.