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MISE AU POINT/IN-DEPTH REVIEW

HYDATID DISEASE: THE LEBANESE CONTRIBUTION

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Araj GF, Mourad Y. Hydatid disease: the Lebanese contribution. J Med Liban 2014 ; 62 (4) : 217-226.

ABSTRACT • Hydatid disease (HD) or cystic echinococcosis (CE) has been an important zoonotic disease causing medical, economic and public health problems in many parts of the world, including South America, North Africa, Turkey, and Middle Eastern countries. Humans as well as animals, primarily sheep and cattle, are infected by the ingestion of food, usually leafy vegetables, contaminated with the eggs (oncospheres) of the dog tapeworm *Echinococcus granulosus*. Hydatid cysts, which are the larval stage of the parasite, are located mostly in the liver and lungs of the infected host. Because of its chronic endemicity in Lebanon and neighboring countries, this disease has constituted an integral part of research studies conducted by medical doctors and researchers in Lebanon, mostly spearheaded by those at the American University of Beirut (AUB) and its medical center (AUBMC) since the early turn of the last century (1920s). Over 130 wide ranging studies were published; some were innovative e.g. the introduction of the once famous Indirect Haemagglutination (IHA) test for serodiagnosis, and the use of dilute cetrimide as a protoscolicidal agent during surgery. Although the incidence of HD is decreasing in our country, it has acquired increasing public health concern and is considered as an emerging or re-emerging disease in many parts of the world. In this review, we shed light on the numerous studies/publications done in Lebanon as a tribute to those researchers who have impacted the literature of HD in many aspects. The latter include epidemiology and ways of transmission, clinical features and radiological tools for diagnosis, serodiagnosis and immunology, and investigation of different therapeutic modalities for different aspects of the disease. Moreover, consolidating these studies in this review would hopefully represent the historic foundation for interested researchers and investigators, especially in this country, to pursue and build on such studies. The advances in technology, and the availability and utilization of new methodologies will hopefully help find more reliable and efficient ways for the diagnosis, and management of this disease.

Keywords : hydatid disease, Lebanon, echinococcosis, *Echinococcus granulosus*

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RÉSUMÉ • La maladie hydatique ou l'échinococcose kystique est une maladie zoonotique causant des problèmes médicaux, économiques et de santé publique dans différentes parties du monde, y compris l'Amérique du Sud, l'Afrique du Nord, la Turquie et les pays du Moyen-Orient. Les hommes aussi bien que les animaux, surtout les moutons et les chiens, sont infectés suite à l'ingestion de légumes feuilles, contaminés par les œufs (oncosphères) de l'*Echinococcus granulosus*. Les kystes hydatiques, qui sont l'étape larvaire du parasite, sont surtout localisés dans le foie et les poumons de l'hôte infecté. Du fait de son endémicité chronique au Liban et dans les pays voisins, cette maladie a longtemps été au cœur des recherches effectuées par des médecins et chercheurs au Liban, surtout ceux de l'Université américaine de Beyrouth (AUB) et son centre médical (AUBMC). Dès le début du siècle dernier, dans les années 20, plus de 130 études ont été publiées ; certaines étaient novatrices, comme par exemple l'introduction du célèbre test d'hémagglutination indirecte pour le sérodiagnostic et l'utilisation de cétrimide dilué comme agent protoscolicide au cours de la chirurgie. Bien que l'incidence de la maladie hydatique soit en décroissance au Liban, elle est considérée comme un problème de santé publique ; c'est aussi une maladie émergente ou ré-émergente dans plusieurs parties du monde. Dans cette revue des nombreuses études et/ou publications réalisées au Liban nous rendons hommage à ces chercheurs et à l'impact de leurs travaux dans la connaissance de plusieurs aspects de la maladie hydatique. Ces derniers incluent l'épidémiologie, les moyens de transmission, les caractéristiques cliniques, radiologiques, sérologiques, et immunologiques nécessaires pour le diagnostic ainsi que les investigations de différentes modalités thérapeutiques. La compilation de ces études constitue une référence de base pour les chercheurs et enquêteurs intéressés à poursuivre des recherches sur ce sujet, en particulier au Libac. Les avancés technologiques ainsi que la disponibilité et l'utilisation de nouvelles méthodologies aideront probablement à trouver des moyens plus fiables et efficaces pour le diagnostic, le traitement et le contrôle de cette maladie.

INTRODUCTION

As a prelude to the contribution of Lebanese researches to hydatid disease (HD) or cystic echinococcosis (CE), an overall refreshing brief summary about this disease is warranted, primarily referring to a couple of publications: one regional and the other international [1-2].

Globally, HD is caused by several *Echinococcus* spp. (cestodal tapeworm). In Lebanon and in the Middle East, however, it is caused by *E. granulosus*, the adult worm of which inhabits the dog's intestine. Ingestion of food or water contaminated by eggs shed in feces from infected dogs can infect humans and a wide range of animals including sheep, cattle, horses, and canines. The eggs develop into embryos within the human intestine. Subsequently, they travel through major blood vessels to different body sites/organs primarily the liver and/or lungs.

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The embryos begin to form cysts within the infected organs causing damage as they enlarge over many years or decades. Hydatid cysts contain a germinal layer that allows asexual budding to form daughter cysts (protoscoleces) within the primary cyst.

The symptoms of HD is primarily due to the pressure/damage exerted by the enlarging cyst on the adjacent sites e.g. obstruction of blood vessels, lymphatics, and/or bile ducts. Moreover, leakage of fluid (containing antigens) from the cyst by either spontaneous or accidental rupture of the cyst, can result in a spectrum of immunologic reactions ranging from asthma and membranous nephropathy to potentially severe, life-threatening anaphylaxis.

Diagnosis of CE is carried out by different methodologies: imaging, serology, histopathology and nucleic acid detection assays.

Treatment of HD is primarily based on surgical removal of the cyst, followed by therapy with albendazole for 1 to 5 months.

This review is intended to shed light on the numerous studies/publications done in Lebanon on hydatid disease in a consolidated presentation. Moreover, reflecting on these overall scientific contributions is intended to be a tribute to those researchers in this country who have impacted the literature of HD. It is also anticipated that consolidating these studies in this review would represent historic foundation for interested researchers and investigators, especially in this country, to pursue and build on such studies. The advances in technology, and the availability and utilization of new methodology will hopefully help find more reliable and efficient ways for the diagnosis, treatment and control of this disease.

MATERIALS & METHODS

The gathering of information pertaining to this review relied on several search sources. These included Pubmed, Medline and the Lebanese corner at Saab Medical Library search using ''cystic echinococcosis,'' ''hydatid'' combined with ''epidemiology,'' ''diagnosis,'' ''treatment,'' ''radiology,'' ''immunology,'' ''prevention'' and ''Lebanon'' as keywords. Additional articles were obtained by contacting specific Lebanese authors who were pioneers in this field. We also contacted the librarian at Saint-Joseph University, Faculty of Medicine, in order to search for any thesis or non published article on this subject by their students and doctors.

We found 134 Lebanese studies/publications done in Lebanon about hydatidosis including original research studies, case reports, reviews, theses, and a book.

RESULTS

I. General aspects of the Lebanese contribution to hydatid disease

The numerous studies/publications done on hydatid disease in Lebanon have impacted the literature of this disease in many aspects. The latter include epidemiology and ways of transmision, clinical features, radiological tools for diagnosis, serodiagnosis and immunology, and investigation of different therapeutic modalities for different aspects of the disease. Although several authors from Lebanon published general information on hydatid disease in adults and children [3-9] this consolidated review is set to present the overall 134 studies under the aforementioned categories as noted below.

II. Epidemiology

Ways of transmission

In Lebanon, HD is not an obligatory reportable disease; that's why official statistics are lacking. Most of the studies on the prevalence of this disease were based on hospital medical records review. They started during the early part of the last century [6, 10-16]. An estimated 3.82 cases per 100,000 population was reported [11]. A change in gender prevalence between males and females was reported. In 1965, no gender difference was reported by Abou-Daoud KT [13], while a higher rates in females was reported by Frayha G *et al*. [16]. The highest rates occurring between ages 20 and 60, with a predominance

TABLE I LEBANESE CONTRIBUTION TO LOCALIZED ORGAN INVOLVEMENT

Location involvement	*Study aspects/Authors*	References
Hepatic (most involved 45%-50%)	*Description of localization in lobes (77% in right),dissemination, complication upon rupture, risk of infection and bacterial types, mostly reported by Daher M (87 cases) & Haddad MC.*	[24-30]
Pulmonary 2nd most involved 30%-35%)	*Reviews and large case series by Haddad S, Srouji (62 cases), Dahan (70 cases), Saade (512 cases), Aubert (8384 cases), mostly unilateral (70%), and 21% in children.*	[23, 31-36]
Skeletal (vertebral, spine)	*Several case series of vertebral and extra vertebral, spine involvement as primary hydatidosis, confused with malignancy, has unfavorable prognosis, mostly reported by Murray R & Haddad F, Bulos S & Nasser N, Haddad FS & Bitar E.*	[37-40]
Brain	*Several case series reported about the confusing clinical presentation, challenges and difficulty in diagnosis, recurrences, role of radiologic diagnosis, mostly addressed by Haddad FS.*	[41-48]
Cardiac	*Mostly appear in adults, affect left heart chamber, misleading presentation, unfavorable prognosis*	[22,49-53]
Other body sites	*Rare case reports on involvement of pancreas, peritoneum and mesocolon, female pelvis, eye orbit, kidney and thigh muscle.*	[54-62]

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among Christians (2:1 Christians to Moslems); the highest rates were found in the Mohafazat of Beirut and Mount Lebanon, and were more common among dog owners. No preference was observed among different social classes [11-12, 16].

Concerning animals, the incidence of *Echinococcus granulosus* was reported as: 20%-33% in dogs (carry the adult worm), 41.5% in cows, 45% in cattle, 6.6%- 22.1% in sheep and goats (all these are intermediate hosts that carry the larval form, like humans) [10, 16-18]. Others, also published about animal infections of hydatid disease in Lebanon and Syria [19-20].

Concerning prevention of HD in Lebanon, a prophylactic program was published by Joseph Asmar in 1958 [21]. It included education of citizens, reduction of canine pets, better conditions in abattoirs, and good cooperation with regional countries to eradicate the disease.

III. Localized organ involvement

Organ involvement by hydatid cysts have been reported by several authors with emphasis on liver and lung [6, 22-23]. Though liver (45-50%) and lungs (30-35%) are the main involved organs in humans, the infection can affect also a wide range of organs: kidneys (5.8%), spleen (4.7%), soft tissues (3.5%), and peritoneum (2.7%) in addition to many other rare locations.

Table I lists the studies addressing different organs by Lebanese authors.

IV. Radiology

Numerous studies were generated by many Lebanese authors on radiologic description and aspects of hydatid disease since 1958, see Table II. They reported on a variety of imaging features that vary according to growth stage, associated complications, affected organs, cyst findings

TABLE II LEBANESE CONTRIBUTION TO RADIOLOGY IN HYDATID DISEASE

Methods	*Study aspects*	Authors/References
Radiography		
Bronchography	Follow-up of some pulmonary hydatidosis cases treated by internal suture of the pericyst to look for either residual cavitation or localized bronchiectasis.	**Srouji M *et al.* 1958** [23]
Conventional radiography	For liver hydatidosis, replaced by US and CT scan	**Rizk G *et al.* 1971** [63]
Angiography	For diagnosing and localizing liver and spleen hydatid cysts	**Rizk G *et al.* 1971** [63]
Plain chest radiography	Screening for pulmonary hydatidosis	**Saksouk F *et al.* 1980** [64]
Melography	An old invasive procedure for spinal hydatidosis but contraindicated because the risk of disseminating the disease intradurally	**Fahl M *et al.* 1994** [65]
Spinal radiography	Nonspecific for spinal hydatidosis and may show bone destruction and sometimes abnormal soft tissue masses in the paravertebral regions	**Fahl M *et al.* 1994** [65]
Ultrasonography		
Abdominal	It confirms the presence of hydatid lesions in the abdomen mainly the liver as well as the internal structure of the cyst and distinguishes simple, calcified and infected hydatid cysts from other fluid filled lesions	**Saksouk F *et al.* 1980** [64] **Haddad M 1999** [9, 66] **Haddad M *et al.* 2001** [27-28, 67] **Naffaa L *et al.* 2003** [68]
Echocardiography	Coupled with CT scan to diagnose cardiac hydatidosis	**Maalouf J *et al.* 1985** [69] **Tedy G *et al.* 1995** [53].
Echoguided percutaneous treatment	Image-guided treatment of complex hepatic hydatid cyst.	**Haddad MC *et al.* 2000** [70] **Haddad MC *et al.* 2001** [67]
Computed tomography		
Cerebral	For intracerebral and extradural intracranial hydatid cysts.	**Baassiri A & Haddad FS 1984** [45]
Thoracic	For pulmonary hydatid cysts.	**Saksouk F *et al.* 1986** [71]
Spinal	Shows clearly the bony destructive changes as well as the paraspinal soft tissue involvement	**Fahl M *et al.* 1994** [65]
Magnetic resonance imaging		
Spinal	It demonstrates the cysts and their extent in the spinal and paraspinal spaces/canal	**Fahl M *et al.* 1994** [65] **Haddad M *et al.* 2001** [67]
Abdominal	Hydatid cyst of the pancreas	**Haddad M 2003** [55]
Functional MRI using DW & MRS	For differentiating parasitic from non parasitic cysts	**Haddad M *et al.* 2011** [72]

US: ultrasonography **CT**: computed tomography **MRI**: magnetic resonance imaging **DW**: diffusion weighted.....**MRS**: proton MR spectroscopy

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and pre-/postoperative assessment of disease. As noted in Table II, different radiologic methodologies were applied including chest radiography, ultrasonography (US), echocardiography, angiography, computed tomography (CT) and magnetic resonance (MR) imaging.

All authors concluded that the simultaneous reliance on radiologic and serologic findings can generally help establish the diagnosis of hydatid disease. Sometimes, a hydatid cyst in an unusual location with atypical imaging findings may complicate the differential diagnosis. Nevertheless, familiarity with imaging findings, especially in patients living in endemic regions, is advantageous in this context.

V. Serologic and immunologic studies

Serodiagnosis is one of the most studied aspects in hydatid disease in Lebanon, reflected in more than 20 published articles, primarily lead by Garabed Garabedian, and Robert Matossian (Table III). Most clinically relevant was the introduction of a new sensitive and specific Indirect Hemagglutination (IHA) test by Garabedian G that is still used today in our routine laboratories.

The immunologic and serologic studies are presented under different categories as shown in Table III.

VI. Treatment options for hydatosis

➢ Experimental approaches in search for anti-hydatid agents

Several studies from AUB targeted revealing the interaction of *E. granulosus* ova with the environment as well as the different aspects of hydatid cell wall and cyst metabolism. Berberian D 1936 and 1957 [104-105] demonstrated the susceptibility of cement substance around ova of *E. granulosus* to alkaline but not acidic conditions. This explained why the ovum passes unaffected through the stomach to the duodenum where the oncosphere (embryo) is liberated.

Schwabe C and colleagues [106-111], as of 1959, carried out several in vitro and in vivo experiments about the cell wall permeability regulation, metabolic, immunologic, therapeutic aspects, and the inhibitory role of acetylcholinesterase.

Kilejian A *et al*. [112-113] studied the distribution of glycogen, acid and alkaline phosphatases, and DNA in both the larval and adult stages of *E. granulosus*, as well as the characteristic of lecithin and cholesterol on hydatid cyst tissues.

Meymerian E and Schwabe C 1962 [114] studied the resistance of the ova of *E. granulosus* to germicides.

TABLE III LEBANESE AUTHORS CONTRIBUTION TO SEROLOGIC AND IMMUNOLOGIC ASPECTS OF HYDATID DISEASE (HD)

Contribution to Serology & Immunology Aspects	Authors/References
Presentation and assessment of different hydatid antigens for use in different serologic tests Different types of antigenic preparations (Crude hydatid fluid filtered, nonfiltered; Purified fluid or extracts of scolices; and Cyst fluid fractions) were studied and compared for the best yield in IHA and complement fixation (CF) tests.	Turner E *et al.* 1935; Emery D 1937 Hariri M *et al.* 1965; Garabedian G 1971 Garabedian G & Zekian-Arslanian B 1976 [73-77]
Garabedian first introduction of indirect haemagglutination (IHA) test for the serodiagnosis of hydatid disease It used RBC treated with tannic acid and coated with hydatid antigen and proved high reliability.	Garabedian G *et al.* 1957; 1957; 1959; 1960 [78-81]
Modifications in Garabedian's method Using pyrovic aldehyde and chrome chloride for coating of antigen and prolonging activity of reagents	Matossian R & Kane G 1971; Mamo 1974 Matossian R *et al.* 1976 [82-84]
Evaluation of different techniques/tests Looking for the most reliable diagnosis of HD especially in relation to liver and pulmonary involvement.	Matossian R *et al.* 1979 Matossian R 1981; 1990 [85-87]
Humoral immunity in humans and mice Determination of total and specific immunoglobulins (IgG, IgM, IgA, IgE) and assessment of their sequential evolution and role versus cyst development, and as relates to hepatic and pulmonary involvement.	Kane G *et al.* 1971; Matossian R *et al.* 1972 Matossian R & Araj G 1975; Araj G *et al.* 1977 Matossian R *et al.* 1976; Matossian R 1977 Haddad E 1990 [88-94]
Serologic follow-up and prognostic values Different tests were used to assess the evolution of antibody detection in humans post-surgery or after medical treatment with albendazole.	Matossian R & Araj G 1975; Kanaan S 1984 Awar G *et al.* 1991; Matossian R 1992 Matossian R *et al.* 1992. [90, 95-97]
Cell mediated immunity (CMI) Studying sequential evolution/response of CMI post infection in mice.	Araj G *et al.* 1976 [98]
Cytology to diagnose pulmonary hydatidosis	Tomb J, Matossian R 1976 [99]
Immunization approaches In search of protection from HD infection.	Turner E *et al.* 1933; 1936 Araj G *et al.* 1976 [98, 100-102]
Study immunologic aspects & HLA genetic association among HD patients from different Lebanese sects	Kanaan S 1984 [95]
Update on laboratory diagnosis of HD	Araj G 2003 [103]

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Frayha G in 1968 [115-116] revealed the de novo synthesis of cholesterol present in the hydatid cyst wall, effect of sex hormone on the growth of the cyst in albino mice.

On another aspect, Rickard M *et al*. 1977 [117] studied the effect of normal serum on protoscoleces and the involvement of the alternate complement pathway in the lysis of these protoscoleces.

➢ Management of hepatic and abdominal cysts

Several studies pertaining to hydatid disease therapy have been published by Lebanese authors starting as early as 1940.

To facilitate clarification of these contributions to therapy of hydatid disease, the WHO 2010 classification will be adopted incorporating the Lebanese studies accordingly.

The WHO guidelines are based on image and stage specific approach, which is helpful for choosing one of the following therapeutic options: Surgery (open and laparoscopic surgery) to remove cysts completely; Percutaneous treatment [PAIR (puncture, aspiration, injection, re-aspiration) technique and the PEVAC (percutaneous evacuation) technique]; Anti-infective drug therapy benzimidazole based (BMZ); and finally, Watch and wait approach.

1. ***Surgery***

Open surgery was the only treatment available for hydatid disease before the 1990's [72, 118-119]. With the availability of effective chemotherapy, percutaneous treatment and laparoscopy became the mainstay in the treatment of non complicated and accessible abdominal hydatid cysts more than 5 cm in size [72].

a. *Open surgery*

In 1940, Haddad S and Khairallah A [120] were the first to publish about the surgical excision of hydatid cyst and its management. In the 1950s onward Jidejian Y [6,118,121-122] spearheaded the studies on HD by publishing several articles describing different surgical techniques according to the location of the hydatid cysts. Later on, he edited a landmark book covering his own surgical experience and other aspects of hydatid disease [6]. In 1971, Haddad FS [123] described a new simple surgical procedure for the removal of hepatic hydatid cysts without opening the cysts and spilling their content into the surrounding tissues.

b. *Laparoscopy*

The first laparoscopic excision of a hepatic hydatid cyst in Lebanon was reported by Khoury G *et al*. at AUBMC in 1994 [124]. Thereafter, other Lebanese surgeons used this surgical technique for the excision of hydatid cysts from liver and spleen with successful follow-up and outcome [125-126].

c. *Surgical complications*

The risks of the open, percutaneous or laporoscopic surgical methods include those associated with any surgical intervention, anaphylactic reactions, and secondary cystic echinococcus (CE) due to spillage of viable parasite material. A couple of publications on such complications and managements were reported [24,127-129].

To prevent CE due to spillage of viable parasites, surgeons have been using cetrimide (see below, under antiparasitic drugs) as a key protoscoliciadal agent, injected into the cyst prior to its excision [72,130-131].

d. *Liver transplantation*

Liver transplantation, which is only rarely needed, was also performed at the AUBMC for a severe case of multiple hydatid cysts of the liver [132].

2. ***Percutaneous treatment and complications***

In 2000, Haddad M *et al*. [70,129] reported on the percutaneous approach as a minimally invasive technique used in the treatment of cysts in the liver, or rarely at other abdominal locations. It is indicated for inoperable patients and those who refuse surgery or relapse after surgery. In addition to using cetrimide, percutaneous treatment is always accompanied by adjunctive chemotherapy using albendazole for 3-7 days prior to the procedure and one month after [128].

The main risks associated with the percutaneous treatment are cyst cavity infection, fistulae and rarely anaphylactic shock [72]. One rare and serious complication was a life-threatening liver laceration with arterial hemorrhage reported in 2008 by Loutfi S *et al*. [133].

The analysis of clinico-radiological findings and different therapeutic modalities of 61 patients with HEC was reported by Haddad M *et al*. [27]. They concluded that HEC are best treated by nonsurgical minimally invasive techniques combined with adjuvant antihelmintic chemotherapy, while surgery should be reserved for complicated HEC by intraperitoneal rupture.

Cystic echinococcosis complicated by rupture into the biliary tree causing biliary obstruction with or without cholangitis is usually treated by endoscopy combined with surgery or percutaneous approach [72].

➢ Anti-parasitic drugs & Chemotherapy

1. ***Protoscolicidal agents***

The experimental search for a protoscolicidal agent was carried out by Meymerian E *et al*. in 1963 [130]. They were the first to introduce the use of an effective and safe cetrimide (cethyl-trimethyl-ammonium-bromide) as a protoscolicidal agent during surgery of hydatidosis to prevent viable protoscolecis from forming secondary hydatidosis. This was demonstrated and concluded after investigating several agents e.g. alcohol, formalin and hypertonic saline solutions, sodium hypochlorite, hydrogen peroxide, iodine and cetrimide. In Lebanon, most surgeons still use cetrimide solution at 0.1%-0.5% for injecting the cysts before surgical excision, Some, however, use 20% hypertonic saline as recommended by the WHO-OIE, 2001 [72].

2. ***Agents for systemic use***

During late 1960s and early 1970s, Frayha G led with collaborators [4,115-116,131,134] the continued search for systemic hydatid agents (through screening 64 chemicals, 13 exhibited high activity) by studying the meta-

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bolic aspect of the parasite. They noted that acetate (ferric and cupric acetylacetonate) was incorporated into the lipids of *E. granulosus* displaying effective scolicidal activity after 10 min of exposure. These studied chemicals were organic and thus amenable to structural modifications, leading the way to developing drugs useful in systemic treatment and prophylaxis of hydatid disease. Today, the benzimidazoles (BMZ) such as albendazole and mebendazole (high dose) are commonly used for the medical therapy of echinococcosis, often as supplementary therapy with either surgery or percutaneous treatments [72].

Schantz P and Nassar N 1982 [135] published about chemotherapy for hydatidosis in animals and humans. Nassar N in 1987 [136] presented the AUBMC experience and the data on 41 patients with inoperable HEC over a six-year period. The results presented in this paper provide strong support in favor of medical treatment with an expected overall success rate of 70% in an otherwise inoperable patient group.

3. *Watch and wait approach*

Some asymptomatic cysts are discovered incidentally on imaging examinations. These cysts do not require any treatment if uncomplicated or inactive and cysts may undergo spontaneous degeneration [72].

➢ Management of cysts in extra-hepatic sites and specific situations

Several publications addressed management of infection in different body sites:

1. *Lung*

For pulmonary echinococcosis, there is no uniform recommended treatment. BMZ's are mainly used for small, uncomplicated lung cysts. However, surgery and radical procedures are needed for extended parenchymal involvement.

Shabb *et al*. in 1995 [137], and Taha *et al*. in 1996 [138] published about surgical treatment of pulmonary hydatidosis. They reported on postoperative complications. They studied 53 patients treated surgically over a period of 10 years who underwent different procedures including evacuation after chemical sterilization, imbrication, marsupialization, lobectomy and segmentectomy. Both imbrication and marsupialization were found to be equally effective methods for treatment of pulmonary hydatid cysts. Anatomic resection was rarely required.

Other surgical techniques were also reported by Lebanese authors. For example, Srouji M *et al*. 1958 [23] described a treatment option for pulmonary hydatidosis by internal suturing of the pericyst after careful removal of the parasite. In 1963, Yacoubian and Dajani [139] described a new technique of handling the pericyst space after removal of a hydatid cyst of the lung. The technique was applicable to both intact and ruptured cysts and does not compromise normal lung tissue and therefore gives good functional results. Thoracoscopy was used by Shabb B *et al*. to successfully treated two cases of infected pulmonary hydatid cysts. [137].

2. *Bone*

Hydatisosis of the bone is the most difficult form of cystic echinococcosis to treat due to multiple recurrencies and complications [37-38,40,43,140]. Radical resection of the affected bone is the most effective treatment but rarely feasible. Multiple recurrences with repeated surgical procedures and a high risk of serious complications such as spinal involvement, fistulae, acute and chronic osteomyelitis is a very common scenario.

3. *Heart*

For heart echinococcosis, surgery is the treatment of choice. Venous filters are used to prevent dissemination, if complete removal of the cyst is impossible. In most cases, and after surgical healing, the prognosis is good with a low rate of recurrence [22,51,69]. Ghanem *et al*. reported on hydatid cyst affecting ventricles [50].

4. *Pancreas*

Pancreatic hydatid cysts are also best treated surgically regardless of their location. The recurrence rate has been reported to be around 10%. For this reason, long-term follow-up is recommended and medical therapy with BMZ's is needed in most cases too. Faraj W *et al*. in 2006 [56] used the laporoscopic technique to excise pancreatic hydatid cysts.

5. *Brain*

Haddad FS pioneered the neurosurgery in this location since 1950s, and reported that brain hydatidosis is best treated surgically and cysts should be best removed intact to avoid recurrence or anaphylaxis [42-44,141]. Najjar M *et al*. in 2007 [44] reported one case and Fares Y *et al*. in 2011 [46] reported 9 cases of successfully managed brain hydatidosis.

A review on the management of hydatid cyst of the brain was published by Haddad GF & Haddad FS in 2000 [141].

CONCLUSION

The Lebanese scientific contribution to hydatid disease started at the turn of the last century. Despite political turmoils, their activities in addressing different aspects of this disease has been sustained till to date, warranting deserving recognition. The numerous studies and investigations carried out on this disease by the Lebanese scientists covered a wide spectrum of disciplines including epidemiology, clinical features, radiological tools for diagnosis, serodiagnosis and immunology, and investigation of different therapeutic modalities for different aspects and/or sites of the disease.

Consolidating these studies in this review reflects not only a tribute and recognition to those Lebanese scientists, but also represents the historic foundation for interested researchers and investigators, especially in this country, to pursue and build on such foundations. The advances in technology, and the availability and utilization of new methodologies will hopefully help find more reliable and efficient ways for the diagnosis, treatment, and control of this disease.

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