Original Investigation

Özgün Araştırma

Turkiye Parazitol Derg

DOI: 10.4274/tpd.galenos.2025.95967

Evaluation of the Agreement of Indirect Hemagglutination Test with Radiologic Methods in the Diagnosis of Cystic Echinococcosis: A Retrospective Analysis of Two-year Laboratory Results

Kistik Ekinokokkoz Tanısında İndirekt Hemaglütinasyon Testinin Radyolojik Yöntemlerle Uyumunun Değerlendirilmesi: İki Yıllık Laboratuvar Sonuçlarının Retrospektif Analizi

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Cite this article as: Günaydın B, Kutlu HH, Baştürk T. Evaluation of the agreement of indirect hemagglutination test with radiologic methods in the diagnosis of cystic echinococcosis: a retrospective analysis of two-year laboratory results. Turkiye Parazitol Derg. [Epub Ahead of Print]

ABSTRACT

Objective: Many studies have been conducted to determine the distribution map of cystic echinococcosis (CE) in our country. However, there is no data from Uşak province in the literature. One of the aims of our study is to present the first hospital data on CE disease from Uşak province. Clinical findings, radiologic, and serologic methods are used in the diagnosis. Many studies have been conducted on the role of these identification methods in the diagnosis of CE. Another aim of our study was to evaluate the contribution of indirect hemagglutination (IHA) method and radiologic imaging results to the diagnosis of CE.

Methods: In our study, IHA results of 320 patient serum sent to our laboratory with suspected CE were obtained through the hospital information management system. Demographic data such as age, gender and imaging reports such as computed tomography, magnetic resonance imaging and ultrasonography were accessed from the hospital information system. Statistical analysis of the data obtained was evaluated using SPSS 25 package program.

Results: Hospital data from Uşak province were presented for the first time and the prevalence was calculated as 19.37%. Unlike previous studies, IHA positivity was statistically higher ($p<0.001$) in the 21-40 age range compared to other age groups in our study. In the diagnosis of CE, the IHA test was found to be inadequate in early [World Health Organization (WHO) type 1] and late stage (WHO type 4-5) cases, while this correlation was better in active lesions.

Conclusion: We think that it would be useful to recommend titer follow-up instead of reporting patients with IHA results of 1/80 and 1/160 as negative and that the use of serologic methods as a supportive tool for radiologic imaging methods in the diagnosis of CE will contribute to accurate diagnosis and treatment follow-up.

Keywords: Echinococcosus, indirect hemagglutination, ultrasonography

ÖZ

Amaç: Kistik ekinokokkoz (KE) hastalığının ülkemizdeki dağılım haritasının tespit edilmesi için pek çok çalışma yapılmıştır. Ancak literatürde Uşak iline ait bir veri bulunmamaktadır. Çalışmamızın amaçlarından birisi KE hastalığına dair Uşak ilinden ilk hastane verilerini sunmaktır. Tanıda klinik bulgulardan, radyolojik, ve serolojik yöntemlerden faydalanılmaktadır. Bu tanımlama yöntemlerinin KE tanısındaki yerine dair pek çok çalışma yapılmıştır. Çalışmamızın bir diğer amacı ise KE tanısında kullanılan indirekt hemaglütinasyon yöntemi (İHA) ile radyolojik görüntüleme sonuçlarının tanıya katkısını değerlendirmektir.

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Received/Geliş Tarihi: 05.11.2024 **Accepted/Kabul Tarihi:** 24.11.2025

Epub: 03.02.2026

Türkiye PARAZİTOLOJİ Dergisi

Yöntemler: Çalışmamızda KE şüphesi ile laboratuvarımıza gönderilen 320 hasta serumunun İHA sonuçları hastane bilgi yönetim sistemi üzerinden alınmıştır. Hastaların yaş, cinsiyet gibi demografik verilerine ve bilgisayarlı tomografi, manyetik rezonans görüntüleme, ultrasonografi gibi görüntüleme raporlarına hastane bilgi yönetim sisteminden ulaşılmıştır. Elde edilen verilen istatistiksel analizi SPSS 25 paket programı kullanılarak değerlendirilmiştir.
Bulgular: Uşak ilinden ilk kez hastane verileri sunulmuş olup prevalansı %19,37 olarak hesaplanmıştır. Önceki çalışmalardan farklı olarak 21-40 yaş aralığında İHA pozitifliğinin çalışmamızdaki diğer yaş gruplarına göre istatistiksel olarak daha fazla olduğu ($p<0,001$) görülmüştür. KE tanısında İHA testinin erken [Dünya Sağlık Örgütü (WHO) tip 1] ve geç evre (WHO tip 4-5) olgularda yetersiz olduğu, aktif lezyonlarda ise bu korelasyonun daha iyi olduğu tespit edilmiştir.
Sonuç: İHA sonucu 1/80 ve 1/160 sonuçlanan hastaları negatif raporlamak yerine titre takibinin önerilmesinin faydalı olacağını ve KE tanısında serolojik yöntemlerin radyolojik görüntüleme yöntemlerini destekleyici olarak kullanılmasının doğru tanı ve tedavi takibine katkı sağlayacağını düşünüyoruz.
Anahtar Kelimeler: Ekinokokkoz, indirekt hemaglütinasyon, ultrasonografi

INTRODUCTION

Echinococcosis is classified by the World Health Organization (WHO) as one of the 17 neglected tropical diseases. It is a zoonotic infection resulting from the larval stages of cestode species belonging to the genus *Echinococcus* (1). The life cycle of *Echinococcus* species involves two mammalian hosts: a carnivorous definitive host (typically a dog) and a herbivorous intermediate host (often a sheep) (2,3). Humans can act as accidental intermediate hosts by ingesting eggs present in dog feces through inadequately washed fruits and vegetables, or by contaminating their hands through contact with contaminated soil or dogs (3,4). In such cases, depending on the species, one of three clinical forms may arise: the cystic form from *Echinococcus granulosus (E. granulosu) sensu lato*, the alveolar form from *Echinococcus multilocularis*, and the polycystic form from *Echinococcus vogeli* (2).

The most common form of echinococcosis is the cystic form, which can be found worldwide except in a few islands. In endemic regions, its incidence can reach as high as 200 cases per 100,000 individuals (5). In mitochondrial DNA sequencing studies, ten genotypes of *E. granulosus* have been identified, with genotype G1 being the most common cause of cystic echinococcosis (CE) in humans and the most widespread type globally (6). The dominant G1 genotype is frequently observed in regions where sheep farming is prevalent, particularly in countries such as western China, Kazakhstan, Kenya, Tunisia, Morocco, and Argentina (5,6).

Recent epidemiological studies have reported that our country is highly endemic for *E. granulosus sensu lato* (5). In a study conducted under the HERACLES project, which investigated the prevalence of CE in Bulgaria, Romania, and Türkiye, abdominal ultrasound (US) screenings were performed on 8,618 volunteers from our country, with 53 individuals (0.59%) found to be positive for abdominal CE (7). Although CE has been a notifiable disease in our country since 2005, the reported case numbers have been significantly lower than expected. Consequently, a revision was made in 2015, and as a result of compiling epidemiological studies conducted between 2009 and 2019, the incidence rate of the disease increased to 8.70 per 100,000 individuals (8).

CE often presents asymptomatically or with non-specific symptoms, leading to most diagnoses being made incidentally during imaging studies. The liver is the most commonly affected organ, making right upper quadrant pain and hepatomegaly the most frequent symptoms (9). The primary diagnostic method for CE is US, which is used for screening in endemic regions, staging, interventional treatments, and follow-up (4,9). Serological methods are frequently used to support the diagnosis. Among these methods, the indirect hemagglutination (IHA) test is often preferred due to its ease of application, low cost, and simplicity in evaluation (4).

In our study, the results of the IHA test for patient sera sent to the Medical Microbiology Laboratory of Uşak Training and Research Hospital with suspected CE were evaluated retrospectively. The demographic data of the patients, such as age and gender, along with reports from US, computed tomography (CT), and magnetic resonance imaging (MRI), were analyzed to investigate the effectiveness of the IHA test in diagnosis and to compile the first hospital data on CE cases observed in Uşak province.

METHODS

Data Collection

The results of the IHA test for patient sera sent to our laboratory with suspected CE between September 2021 and August 2023 were evaluated retrospectively. For duplicate cases, only the first sample was included in the study. Demographic data such as age and gender, as well as reports from US, CT, and MRI, were obtained using the hospital information management system (HIMS).

Indirect Hemagglutination Test

Anti-*E. granulosus* antibodies were investigated using a commercial IHA test kit (ELITech Microbio, France) in patient serum samples. The test was conducted using U-bottom microplates with serum dilutions of 1/80, 1/160, 1/320, and 1/640. The absence of sediment or the presence of irregular sediment resembling lace in the antigen-coated red blood cell suspension was considered positive, while a point-like sediment at the center of the wells was deemed negative. In accordance with the manufacturer's recommendations, titers of 1:320 and above were reported as positive. A titer of 1:160 was considered suspicious, and it was recommended that samples be repeated 2-3 weeks later. Titers of 1/80 and below were interpreted as negative.

Radiological Evaluation

The most recent US, CT, and MRI examinations of the patients conducted prior to the IHA test requests were reviewed through the HIMS. The US reports were evaluated, while the CT and MRI examinations were assessed through the hospital's picture archiving and communication system using multiplanar analysis in axial, coronal, and sagittal planes. The imaging findings were evaluated retrospectively by the same radiologist. Patients with findings suggestive of CE in the liver were radiologically classified according to the WHO Informal Working Group on Echinococcosis classification (10). According to this classification: type 1 includes unilocular anechoic cysts, cysts containing echogenicities within the hydatid material, or cysts exhibiting a double contour on the wall; type 2 comprises complex cysts with multiple septa that display a rosette or honeycomb appearance; type 3 encompasses

cysts with membrane disintegration (lily pad appearance) and lesions containing daughter vesicles within a solid matrix; type 4 refers to solid, heterogeneous lesions that are hypoechoic or hyperechoic, resembling a wool ball; and type 5 includes solid lesions characterized by wall calcifications, all evaluated as indicative of hydatid cyst lesions.

Statistical Analysis

Statistical analyses of the data obtained in this study were conducted using SPSS version 25 (IBM Corp., Armonk, NY, USA). Descriptive statistics were employed to determine the percentage distributions of the data, and frequency tables were generated accordingly. The chi-square test was used to evaluate the statistical significance of the associations between two variables. A significance level of $p<0.05$ was established for all analyses.

Ethical Authorisation

Our study was approved by the decision of Uşak University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (decision no: 320-320-19, date: 15.02.2024), and the Helsinki Declaration criteria were taken into consideration.

RESULTS

Among the 320 patients tested for suspected CE, 174 (54%) were female and 146 (46%) were male. IHA test was positive in 62 patients, resulting in a seroprevalence rate of 62/320 (19.37%). The seroprevalence rate among female patients was 38/174 (21.84%), while it was 24/146 (16.44%) among male patients. When analyzed by age distribution, the highest seroprevalence was observed in the age group of 21-40 years (26/320, 8.13%). This age group also exhibited the highest prevalence when assessed separately by gender. The distribution of patients tested with the IHA test by age and gender is shown in Table 1.

When the radiological imaging studies of the patients for whom indirect haemagglutination test was requested were evaluated, the imaging studies of 30 patients, most of whom had negative IHA results, could not be reached. Upon reviewing the available radiological imaging, the rate of finding suggestive of CE in cases with negative IHA results was 55/258 (21.3%), whereas this rate was 56/62 (90.3%) in cases with positive IHA results. According to radiological imaging data in this patient population, seropositivity was 111/320 (34.6%). The detailed evaluation of radiological imaging reports according to the IHA results of the patients in whom IHA test was performed is shown in Table 2.

When the organ distribution in the images was analysed; cystic lesion in the liver was observed in 154 patients alone and in 28 patients with an additional organ. The images of 106/182 (58.2%) of these patients were evaluated in suggestive of CE. Indirect haemagglutination was positive in 54/106 (51%) of these patients with a titre of 1/320 and above. While the rate of evaluation of radiological imaging of patients with 0-1/40 dilutions in suggestive of CE was quite low, this rate was higher at dilutions of 1/80 and above. The organ localisations in which cystic lesions were seen on radiological imaging according to the results of the IHA test are shown in detail in Table 3. The WHO classification of the lesions in the liver in which CE was considered was made according to the scoring and shown in Table 4.

Table 1. Distribution of samples tested by indirect haemagglutination by age and gender; n (%)

Age group	Gender	0-1/40	1/80	1/160	All negatives	1/320	1/640	All positives	T
0-20	F	15 (8.62)	2 (1.14)	1 (0.57)	18 (10.34)	2 (1.14)	1 (0.57)	3 (1.72)	**21 (12.07)**
	M	20 (13.69)	1 (0.68)	0 (0)	21 (14.38)	1 (0.68)	2 (1.36)	3 (2.05)	**24 (16.44)**
	T	35 (10.93)	3 (0.93)	1 (0.31)	39 (12.18)	3 (0.93)	3 (0.93)	6 (1.87)	**45 (14.06)**
21-40	F	16 (9.19)	4 (2.29)	2 (1.14)	22 (12.64)	4 (2.29)	12 (6.9)	16 (9.2)	**38 (21.84)**
	M	16 (10.95)	2 (1.36)	3 (2.05)	21 (14.38)	2 (1.36)	8 (5.48)	10 (6.85)	**31 (21.23)**
	T	32 (10)	6 (1.87)	5 (1.56)	43 (13.43)	6 (1.87)	20 (6.25)	26 (8.13)	**69 (21.56)**
41-60	F	45 (25.86)	6 (3.44)	5 (2.87)	56 (32.18)	4 (2.29)	9 (5.17)	13 (7.47)	**69 (39.66)**
	M	33 (22.6)	0 (0)	3 (2.05)	36 (24.65)	0 (0)	6 (4.11)	6 (4.11)	**42 (28.77)**
	T	78 (24.37)	6 (1.87)	8 (2.5)	92 (28.75)	4 (1.25)	15 (4.69)	19 (5.94)	**111 (34.69)**
61-80	F	33 (18.96)	2 (1.14)	3 (1.72)	38 (21.83)	0 (0)	6 (3.45)	6 (3.45)	**44 (25.29)**
	M	37 (25.34)	1 (0.68)	2 (1.36)	40 (27.4)	1 (0.68)	4 (2.73)	5 (3.42)	**45 (30.82)**
	T	70 (21.87)	3 (0.93)	5 (1.56)	78 (24.37)	1 (0.31)	10 (3.13)	11 (3.44)	**89 (27.81)**

Table 1. Continued

Age group	Gender	0-1/40	1/80	1/160	All negatives	1/320	1/640	All positives	T
>80	F	2 (1.14)	0 (0)	0 (0)	2 (1.14)	0 (0)	0 (0)	0 (0)	**2 (1.14)**
	M	3 (2.05)	0 (0)	1 (0.68)	4 (2.74)	0 (0)	0 (0)	0 (0)	**4 (2.74)**
	T	5 (1.56)	0 (0)	1 (0.31)	6 (1.87)	0 (0)	0 (0)	0 (0)	**6 (1.88)**
All ages	F	111 (63.79)	14 (8.04)	11 (6.32)	136 (78.16)	10 (5.74)	28 (16.1)	38 (21.84)	**174 (100)**
	M	109 (74.65)	4 (2.73)	9 (6.16)	122 (83.56)	4 (2.73)	20 (13.7)	24 (16.44)	**146 (100)**
	T	**220 (68.75)**	**18 (5.62)**	**20 (6.25)**	**258 (80.65)**	**14 (4.37)**	**48 (15)**	**62 (19.37)**	**320 (100)**

F: Female, M: Male, T: Total

Table 2. Evalution of radiological imaging results of samples tested by indirect haemagglutination; n (%)

IHA results	Samples without radiological imaging	Samples with radiological imaging	Presence of a cyst (+)	Finding suggestive of CE (+)	Total number of samples (n)
0-1/40	24 (10.9)	196 (89.1)	143 (65)	29 (13.1)	220 (100)
1/80	3 (16.7)	15 (83.3)	13 (72.2)	13 (72.2)	18 (100)
1/160	2 (10)	18 (90)	14 (70)	13 (65)	20 (100)
All negatives	**29 (11.2)**	**229 (88.8)**	**170 (65.9)**	**55 (21.3)**	**258 (100)**
1/320	1 (7.1)	13 (92.9)	13 (92.9)	13 (92.9)	14 (100)
1/640	0 (0)	48 (100)	46 (95.8)	43 (89.5)	48 (100)
All positives	**1 (1.6)**	**61 (98.4)**	**59 (95.2)**	**56 (90.3)**	**62 (100)**
Total	**30 (9.4)**	**290 (90.6)**	**229 (71.6)**	**111 (34.6)**	**320 (100)**

IHA: Indirect hemagglutination, CE: Cystic echinococcosis

Table 3. Distribution of organs with cystic lesions in the radiological imaging of IHA-tested specimens with cystic lesions/suggestive of CE

Organ localisation of the lesion	0-1/40	1/80	1/160	1/320	1/640	Total
Liver	84/26	12/12	11/11	11/11	36/36	154/96
Lung	1/0	0	0	0	2/1	3/1
Spleen	7/0	0	0	0	1/1	8/1
Kidney	27/0	0	1/0	0	2/0	30/0
Surrenal gland	1/0	0	0	0	0	1/0
Mediastinum	2/1	0	0	0	0	2/1
Over	1/0	0	0	0	0	1/0
Retroperitoneum	2/1	0	0	0	0	2/1
Liver and lung	1/1	0	0	1/1	2/2	4/4
Liver and retroperitoneum	0	0	0	0	1/1	1/1
Liver and kidney	13/0	0	1/1	0	0	14/1
Liver and spleen	1/0	0	1/1	0	0	2/0
Liver and paracolic area	0	1/1	0	0	0	1/1
Liver and adrenal gland	1/0	0	0	0	0	1/0
Liver and pancreas	1/0	0	0	0	0	1/0
Liver, spleen, intraabdominal	0	0	0	1/1	1/1	2/2
Liver, lung, kidney	1/0	0	0	0	0	1/0
Liver, kidney, subcutaneous fat tissue	0	0	0	0	1/1	1/1
Total	**143/29**	**13/13**	**14/13**	**13/13**	**46/43**	**229/111**

IHA: Indirect hemagglutination, CE: Cystic echinococcosis

Table 4. WHO classifications of lesions with cysts in the liver on radiological imaging and IHA results

	CE (-)		WHO 1		WHO 2		WHO 3		WHO 4		WHO 5		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0-1/40	75	100	3	14.3	5	15.2	0	0	11	61.1	8	36.4	102	56.1
1/80	0	0	4	19	3	9	2	15.4	1	5.6	3	13.6	13	7.1
1/160	0	0	3	14.3	5	15.2	3	23.1	0	0	2	9.1	13	7.1
All negatives	**75**	**100**	**10**	**47.6**	**13**	**39.4**	**5**	**38.5**	**12**	**66.7**	**13**	**59.1**	**128**	**70.3**
1/320	0	0	2	9.5	3	9	1	7.7	3	16.7	4	18.2	13	7.1
1/640	0	0	9	42.9	17	51.6	7	53.8	3	16.7	5	22.7	41	22.6
All positives	**0**	**0**	**11**	**52.4**	**20**	**60.6**	**8**	**61.5**	**6**	**33.3**	**9**	**40.9**	**54**	**29.7**
Total	**75**	**100**	**21**	**100**	**33**	**100**	**13**	**100**	**18**	**100**	**22**	**100**	**182**	**100**

IHA: Indirect hemagglutination, CE: Cystic echinococcosis, WHO: World Health Organization

DISCUSSION

CE is widely distributed disease, with endemic areas on every continent. It is particularly common in Mediterranean countries, specific regions of Russia, Western China, Central Asia, Australia, South America, and many temperate climate zones (6). Although the mortality rate from CE is relatively low (0.2 per 100,000 individuals), the disease contributes substantially to morbidity and results in significant workforce productivity losses. Despite its preventable nature, CE remains underreported and often overlooked. For this reason, the WHO has classified it as a neglected tropical disease, with a goal of control or eradication by 2030. Nevertheless, with an estimated 2-3 million cases occurring annually worldwide, achieving this goal remains a considerable challenge (3).

Ultrasonography is the primary diagnostic method for CE, also serving an essential role in disease staging, interventional treatments, and follow-up. Serological methods are frequently used to support the diagnosis, with the IHA being a preferred option due to its ease of use, low cost, and straightforward evaluation process (4,9). In cases suspected of CE, the IHA test is commonly applied in our country as an auxiliary diagnostic tool. Studies conducted on patients with a preliminary diagnosis of CE report a seropositivity rate of 10-20% (4,11-14). For example, in an 8-year study from Adıyaman covering January 2013 to December 2020, 244 out of 1,607 patients (15.18%) tested positive for CE using the IHA method (11). Similarly, 9.5% of patients tested at Erzurum Regional Training and Research Hospital between 2009 and 2013 were IHA positive for CE (12). Another study in Bolu, conducted between 2013 and 2018, found a 10.6% seropositivity rate among 644 patients whose serum samples were sent for CE testing (13). In Balıkesir, a retrospective study of IHA data from 2011 to 2013 reported a seropositivity rate of 19.8% (14). Our study yielded comparable seropositivity rates, with 62 of 320 patients (19.37%) testing positive at a titer of 1/320 or above by IHA during the two-year period from September 2021 to August 2023.

Many studies have found that the seropositivity rate in the IHA is higher in women compared to men (11-13). An exception to this trend was observed in a study conducted in İzmir, which analyzed two years of data and reported a higher seropositivity rate in men (4). However, considering that the study period coincided with the COVID-19 pandemic, a new study incorporating data from a broader timeframe found that between 2017 and 2020, seropositivity rates in female patients were indeed higher than in male patients. Additionally, a statistically significant decrease in IHA positivity rates during the pandemic was reported (15). In our study, the seropositivity rate was higher in female patients (21.84%) compared to male patients (16.44%). However, no significant difference was observed between the sexes regarding IHA test positivity (r=1.482, p=0.223).

In the study conducted by Topluoğlu (16) which presented the case data of CE reported to the Ministry of Health, the incidence rate exceeded 1.60 per 100,000 in 19 provinces. The top three provinces in this ranking were Van, Ağrı, and Iğdır. A regional analysis of the reported data showed that eight provinces were located in the Eastern Anatolia Region and six in the Central Anatolia Region. Reviews of studies calculating CE frequency based on IHA test results indicated that the findings were independent of geographical regions. For example, Yılmaz et al. (12) identified a seropositivity rate of 9.5% (191/2009) in Erzurum, while Bagcı et al. (4) reported a rate of 14.12% (75/531) in İzmir. These differences could have arisen from reporting issues concerning CE cases and the lack of sufficient data from other provinces. In the Aegean Region, where our study took place, other research showed seropositivity rates of 13.39% (28/209) in Aydın and 10.1% (49/483) in Manisa (17,18). In our study, we detected the first CE seroprevalence data specific to Uşak province, with a rate of 19.37% (62/320), which was higher than those reported in previous regional studies. This higher rate may have come from more common animal husbandry practices in Uşak compared to the two cities that reported data.

Tevfik et al. (19) reported the highest seropositivity rate (24.01%) in the 21-30 age group, a finding corroborated by Aldemir et al. (20) who identified a similar rate of 23.07% in the same age range. Ulusan Bağcı's (15) study also indicated that the most common age range for diagnosis, both before and after the COVID-19 pandemic, was 20-39 years. In our study as well, the highest IHA test positivity rate was found in the 21-40 age group (41.9%). This age group showed a statistically higher IHA positivity rate compared to other age groups (r=20.462, p<0.001).

Among the 320 samples included in the study, 9.4% lacked any recorded radiological imaging in the hospital information system (HIS). Of the 258 samples that tested negative by the IHA test, 170 (65.9%) showed cysts in radiological images. However, only 55 of these (21.3%) were assessed as indicative of CE. This rate was found to be 13.1% at dilutions of 1/40 or lower, 72.2% at a 1/80 dilution, and 65% at a 1/160 dilution. These findings suggest

that serological testing can support radiological examinations within the diagnostic algorithm.

In the study, radiological imaging data were unavailable in the HIS for one of the 62 patients who tested positive for IHA at titers of 1/320 or higher. Among patients with a seropositivity of 1/320, all available radiological examinations revealed findings consistent with CE. For the 48 patients with 1/640 seropositivity, two patients had a history of surgery for CE, explaining the absence of cysts in their imaging results. Three additional patients with 1/640 titers and visible cysts on imaging had also undergone surgery for CE, yet their current imaging suggested lesions inconsistent with CE. These cystic lesions were instead classified as Bosniak category 1 cysts in the kidneys.

In the analysis of negative IHA cases, only 13.1% of samples with 0-1/40 titers showed radiological findings indicative of CE, while samples with 1/80 and 1/160 titers had findings at rates of 72.2% and 60%, respectively. Bagcı et al. (4) also noted CE indicators in 60.7% and 73.3% of cases at titers of 1/80 and 1/160, respectively. According to IHA test guidelines, a 1/80 result is considered negative, and patients with 1/160 results are advised to retest in 2-3 weeks. However, our findings show that a notable proportion of patients with 1/80 titers exhibited radiological indicators. Thus, rather than categorizing 1/80 titers as negative, we suggest that reporting these titers—similar to 1/160 results—along with a recommendation for repeat testing in several weeks, would improve the diagnostic and treatment process.

A detailed evaluation of the radiological images of the patients included in the study showed that 154 cases had cysts isolated to the liver, while 28 cases exhibited cysts in the liver along with one or more other organs or tissues. Among the 154 cases with liver-only cysts, 96 (62.3%) were evaluated as indicative of CE. The remaining 58 liver cysts were attributed to other causes, such as simple cysts, biliary hamartomas, polycystic kidney disease-related cysts, and metastases.

For the 28 cases with cysts in both the liver and additional organs or tissues, 10 cases (37%) were considered consistent with CE. Isolated kidney cysts were observed in 30 cases, and in 16 cases, kidney cysts were accompanied by cysts in one or more other organs or tissues. Nearly all kidney cysts were consistent with simple parenchymal cysts, commonly seen in middle-aged and elderly individuals. Among three cases with cysts isolated to the lungs, one case (33.3%) showed findings consistent with CE. In five cases with cysts in the lungs along with other organs or tissues, four cases (80%) were deemed suggestive of CE.

Our study aligns with the literature (4,11,13,21,22), identifying the liver as the most frequently involved organ in CE cases, observed in 96 out of 111 cases (86.5%), followed by combined liver and lung involvement, observed in 4 out of 111 cases (3.6%).

In our study, patients with CE findings in the liver were evaluated, and it was observed that those with a titer of 1/640 were primarily classified under WHO type 2 (53.8%), indicative of viable cysts. Conversely, patients with CE findings in the liver who were seronegative (titer 0-1/40) were predominantly categorized under the inactive cyst groups, WHO type 4 (61.1%) and type 5 (36.4%) (Table 4). Previous studies have reported high false-negative rates for early and late-stage cysts (4,23,24). Consistent with the literature, our study found that most CE patients with negative IHA results were classified under WHO types 1, 4, and 5.

Study Limitations

Our study has some limitations. As a retrospective, single-center study, US data were evaluated based on recorded reports, detailing the localization of CE lesions but not their dimensions.

CONCLUSION

In conclusion, this study provides the first hospital-based data on CE from Uşak province, with a calculated seropositivity rate of 19.37%. Consistent with the literature, no significant difference was found in CE prevalence between genders. Unlike previous studies, however, we observed a statistically higher IHA positivity among those aged 21-40 compared to other age groups in our study ($p<0.001$). The findings also indicate that the IHA test is less effective in diagnosing early (WHO type 1) and late-stage (WHO types 4-5) cases, but shows better correlation with active lesions. Given that CE was confirmed in 111 out of 229 patients with radiologically detected cystic lesions, we believe serological methods should complement radiological imaging to support accurate diagnosis and treatment.

*Ethics

Ethics Committee Approval: Our study was approved by the decision of Uşak University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (decision no: 320-320-19, date: 15.02.2024), and the Helsinki Declaration criteria were taken into consideration.

Informed Consent: The results of the IHA test for patient sera sent to our laboratory with suspected CE between September 2021 and August 2023 were evaluated retrospectively.

*Authorship Contributions

Design: B.G., Data Collection or Processing: B.G., T.B., Analysis or Interpretation: B.G., H.H.K., T.B., Literature Search: B.G., H.H.K., Writing: B.G., H.H.K., T.B.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Agudelo Higuita NI, Brunetti E, McCloskey C. Cystic echinococcosis. J Clin Microbiol. 2016; 54: 518-23.
2. Hermelin D, Demske M, Chamberland RR, Sotelo-Avila C. The brief case: incidental finding of cystic echinococcosis during evaluation for hepatitis. J Clin Microbiol. 2019; 57: e01551-18.
3. Govindasamy A, Bhattarai PR, John J. Liver cystic echinococcosis: a parasitic review. Ther Adv Infect Dis. 2023; 10: 20499361231171478.
4. Bagcı, OU, Pektas B, Gokmen AA, Kaya S. Kistik ekinokokkoz tanısında indirekt hemaglütinasyon testinin kullanılması: iki yıllık retrospektif laboratuvar deneyimi [Use of indirect hemagglutination test in the diagnosis of cystic echinococcosis: two years of retrospective laboratory experience]. Turk Mikrobiyol Cemiy Derg. 2022; 52: 223-31.
5. Wen H, Vuitton L, Tuxun T, Li J, Vuitton DA, Zhang W, et al. Echinococcosis: advances in the 21st century. Clin Microbiol Rev. 2019; 32: e00075-18.
6. Tünger Ö. Dünyada kistik ekinokokkoz epidemiyolojisi [Epidemiology of cystic echinococcosis in the world]. Turkiye Parazitol Derg. 2013; 37: 47-52.
7. Tamarozzi F, Akhan O, Cretu CM, Vutova K, Akinci D, Chipeva R, et al. Prevalence of abdominal cystic echinococcosis in rural Bulgaria, Romania,

and Turkey: a cross-sectional, ultrasound-based, population study from the HERACLES project. Lancet Infect Dis. 2018; 18: 769-78.

8. Durgun C, Alkan S, Durgun M, Dindar Demiray EK. Türkiye'den kist hidatik konusunda yapılmış yayınların analizi [Analysis of published articles on hydatid cysts from Turkey]. BSJ Health Sci. 2022; 5: 45-9.
9. Ferrer Inaebnit E, Molina Romero FX, Segura Sampedro JJ, González Argenté X, Morón Canis JM. A review of the diagnosis and management of liver hydatid cyst. Rev Esp Enferm Dig. 2022; 114: 35-41.
10. WHO Informal Working Group. International classification of ultrasound images in cystic echinococcosis for application in clinical and field epidemiological settings. Acta Trop. 2003; 85: 253-61.
11. Çelik T, Alev C, Akgün S, Güldoğan E, Şahin F. A retrospective evaluation of serological results of cystic echinococcosis suspected cases admitted to Adıyaman Training and Research Hospital between 2013-2020. Turkiye Parazitol Derg 2022; 46: 140-4.
12. Yılmaz A, Uslu H, Aktaş F. 2009-2013 yılları arasında Erzurum Bölge Hastanesindeki kistik ekinokokkozis şüpheli hastaların indirekt hemaglütinasyon (İHA) metoduyla değerlendirilmesi. Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi. 2016; 5: 23-32.
13. Behçet M, Avcıoğlu F. Kistik ekinokokkozis şüpheli hastaların indirekt hemaglutinasyon yöntemiyle değerlendirilmesi [Evaluation of patients with suspected cystic echinococcosis with indirect hemagglutination method]. J Biotechnol and Strategic Health Res. 2020; 4: 26-31.
14. Şafak B. Balıkesir Atatürk Devlet Hastanesi 2011-2013 yılları arası kistik ekinokokkozis serolojisi sonuçları [Serology results of cystic echinococcosis between 2011-2013 in Balıkesir Atatürk State Hospital]. KTD. 2016; 16: 265-8.
15. Ulusan Bağcı Ö. Evaluation of the impact of the COVID-19 pandemic on cystic echinococcosis indirect hemagglutination test dynamics: a single-center experience. Turkiye Parazitol Derg. 2023; 47: 166-70.
16. Topluoğlu S. Türkiye'de kistik ekinokokkoz mevcut durum raporu. Turk Hij Den Biyol Derg. 2020; 77: 1-52.
17. Ertabaklar H, Dayanır Y, Ertuğ S. Aydın ilinin farklı bölgelerinde ultrason ve serolojik yöntemlerle kistik ekinokokkoz araştırılması ve eğitim çalışmaları [Research to investigate human cystic echinococcosis with ultrasound and serologic methods and educational studies in different provinces of Aydın/Turkey]. Turkiye Parazitol Derg. 2012; 36: 142-6.
18. Ozkol M, Kilimcioğlu AA, Girginkardeşler N, Balcioğlu IC, Sakru N, Korkmaz M, et al. A discrepancy between cystic echinococcosis confirmed by ultrasound and seropositivity in Turkish children. Acta Trop. 2005; 93: 213-6.
19. Tevfik M, Aldemir OS, Karadaş K, Çelik T, Daldal N. Malatya bölgesinde uniloküler kistik ekinokokkozis. Turkiye Parazitoloji Derg. 2000; 24: 33-6.
20. Aldemir OS, Baykan M, Gökçen A. Konya Numune Hastanesinde 1986-1998 yılları arasındaki kist hidatik olgularının retrospektif değerlendirilmesi. Turkiye Parazitoloji Derg. 2000; 24: 73-5.
21. Ok ÜZ, Kilimcioğlu AA, Özkol M. Türkiye'de insanlarda kistik ekinokokkoz [Cystic echinococcosis in humans in Turkey]. Mikrobiyol Bul. 2020; 54: 510-22.
22. Esenkaya Taşbent F, Yağcı B, Kadıyoran C, İyisoy MS. Comparative evaluation of the efficacy of indirect hemagglutination test and radiological methods in the pre-diagnosis of cystic echinococcosis. Turkiye Parazitol Derg. 2021; 45: 22-7.
23. Özcel MA, Özbel Y, Ak M. Özcel'in tıbbi parazit hastalıkları. Türkiye Parazitoloji Derneği. 2007.
24. Derbel F, Zidi MK, Mtimet A, Hamida MBH, Mazhoud J, Youssef S, et al. Hydatid cyst of the pancreas: a report on seven cases. Arab Journal of Gastroenterology. 2010; 11: 219-22.