Role MRI and diffusion-weighted imaging in the diagnosis of hydatid cysts of the liver experience on 1 Tesla open magnet MRI

Poster No.: C-1387
Congress: ECR 2011
Type: Scientific Paper
Authors: A. H. A. A. Afifi; Alexandria/EG
Keywords: Abdomen, Liver, MR, MR-Diffusion/Perfusion, Diagnostic procedure, Comparative studies, Cysts, Infection, Congenital
DOI: 10.1594/ecr2011/C-1387

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Purpose

The purpose of our study was to evaluate the role of MRI in imaging and diagnosis of hydatid cystic disease of the liver, differentiating cyst types with demonstrating the value of diffusion-weighted imaging (DWI) in all types of hydatid cyst especially in the differential diagnosis of simple and hydatid cysts of the liver, particularly in the completely liquid type of hydatid cyst.

Methods and Materials

Twenty seven cysts (proved later to be 12 simple cysts and 15 hydatid cysts) were included in this prospective study. Routine T1 and T2 axial and coronal MRI sequences and DWI was performed using a breath-hold single-shot echo-planar spin-echo sequence in different b values (0, 500 and 1000) , and then apparent diffusion coefficients (ADCs) were calculated. The study was performed upon 1 tesla open magnet MRI using body coil.

On DW trace images, the signal intensity of cysts was visually compared with the signal intensity of the adjacent normal liver parenchyma using a 3-point scale: 0, isointense to normal hepatic parenchyma; 1, moderately hyperintense; and 2, significantly hyperintense.

Quantitatively, signal intensity of the cysts, cyst-to-liver signal intensity ratios, ADC of the cysts, and cyst-to-liver ADC ratios were compared between the groups. Then the statistical significance was determined.

Results

• On routine MRI T1 and T2 sequences, excellent ability of MRI to delineate cyst wall, cyst contents, small cysts till size of 2 mm as well as to determine exact number of cysts in cases presented with polycystic liver disease or multiple hydatosis. In addition MRI assessment of the surrounding liver parenchyma and determining if any complications are associated with hydatid disease.

• Types presented include: unilocular cystic lesions with uniform fluid contents and with no visible wall (the completely liquid type), univesicular with a visible cyst wall (cystic echinococcosis type 1), multivesicular appearance
(cystic echinococcosis type 2), and cysts had a floating membrane (cystic echinococcosis type 3). Cystic echinococcosis types 4 and 5 (completely or partially calcified cysts) and cysts below 1 cm in diameter were not included in our study because of limited MRI and DWI resolution.

**Qualitative Analysis**

- Results of the visual evaluation of the signal intensity of the hydatid cysts and simple cysts in diffusion trace images with a b factor of 1,000 s/mm$^2$ are evaluated where most of the hydatid cysts were hyperintense, whereas none of the simple cysts showed significant hyperintensity.

- DWI with a b factor of 1,000 s/mm$^2$ successfully differentiated simple cysts from hydatid cysts. DW images with a b factor of 500 s/mm$^2$ did not help in distinguishing simple cysts from hydatid cysts because all hydatid cysts and simple cysts were significantly hyperintense on these images.

**Quantitative Analysis**

- The results of the quantitative analysis of the DW images are reviewed. With b factors of 0 and 500 s/mm$^2$, no difference of statistical significance was achieved ($p > 0.05$). With a b factor of 1,000 s/mm$^2$, the signal intensities and signal intensity ratios of the hydatid cysts were significantly higher than those of the simple cysts ($p < 0.001$). The best discriminative parameter was signal intensity ratio.

- With a cutoff value of 1.5 for the signal intensity ratio, that ratio had a sensitivity of 71%, specificity of 80%, and positive predictive value of 78%. The ADCs and ADC ratios of hydatid cysts were significantly lower than those of simple cysts ($p < 0.001$). Setting the cutoff value at 1.4, we found a sensitivity of 41%, a specificity of 76%, and positive predictive value of 64% for the ADC ratio. With a cutoff value of 2, we achieved a higher sensitivity (91%) but markedly lower specificity (44%) and positive predictive value (69%).

- Considering the completely liquid type hydatid cysts and simple cysts, we observed statistically significant differences in signal intensity, signal intensity ratio, ADC, and ADC ratio ($p < 0.005$). With a cutoff value of 1.5, signal intensity ratio had a sensitivity of 87%, specificity of 91%, and positive predictive value of 78%. Setting the cutoff value at 2, we found a sensitivity of 85%, specificity of 57%, and positive predictive value of 49% for the ADC ratio.
• The diagnosis of the hydatid cysts was confirmed by biopsy in 11 patients (the presence of scolices or hooklets in the hydatid liquid) and by positive serology for hydatidosis in 18 patients who were hemagglutinin inhibition-positive for dilutions 1/160.

• All patients with a preliminary radiologic diagnosis of simple cyst had negative hemagglutinin inhibition test results, and these lesions showed no change during follow-up (sonography every 3 months for 6-15 months).

Images for this section:

Fig. 1: Case I: Coronal T2, (B) axial ADC, (C) 1,2,3 DWI in b values 0,500,1000 respectively revealed hyperintense T2 signals of right lobe cyst showing no detectable cyst wall, high signals in ADC and gradual diminished diffusion restriction till exhibiting no restricted on DWI b value 1000 (in (C)3). Follow up confirmed the diagnosis of simple hepatic cyst.
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**Fig. 6:** Case II: Coronal T2 (A) and Axial DWI (b values 0, 500, 1000) showing proved simple left lobe ovoid shape hepatic cyst exerting homogenous T2 high signals with no cyst wall and restricted diffusion in b values 0, 500 while no diffusion exerted in b value 1000
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Fig. 10: Case III: Demonstrating shine through artifact where the cyst exhibits high signals in DWI (A) and ADC (B). Image (C) showing ROI (region of interest) noted as red circle for ADC measurements put in the centre of the cyst.
**Fig. 11:** Case III: Demonstrating shine through artifact where the cyst exhibits high signals in DWI (A) and ADC (B). Image (C) showing ROI (region of interest) noted as red circle for ADC measurements put in the centre of the cyst.

**Fig. 12:** Case III: Demonstrating shine through artifact where the cyst exhibits high signals in DWI (A) and ADC (B). Image (C) showing ROI (region of interest) noted as red circle for ADC measurements put in the centre of the cyst.
**Fig. 13:** Case IV: Coronal (A) and axial (B) T2 WI, ADC (C) and DWI in different b values 0,500,1000 (D1,2,3) respectively show typical features of liquid type hydatid cyst showing no visible cyst wall, clear fluid signals, no contents with diffusion restriction increased with increased b value and diminished signals in ADC map.
**Fig. 14:** Case IV: Coronal (A) and axial (B) T2 WI, ADC (C) and DWI in different b values 0,500,1000 (D1,2,3) respectively show typical features of liquid type hydatid cyst showing no visible cyst wall, clear fluid signals, no contents with diffusion restriction increased with increased b value and diminished signals in ADC map.
Fig. 15: Case IV: Coronal (A) and axial (B) T2 WI, ADC (C) and DWI in different b values 0,500,1000 (D1,2,3) respectively show typical features of liquid type hydatid cyst showing no visible cyst wall, clear fluid signals, no contents with diffusion restriction increased with increased b value and diminished signals in ADC map.
Fig. 16: Case IV: Coronal (A) and axial (B) T2 WI, ADC (C) and DWI in different b values 0,500,1000 (D1,2,3) respectively show typical features of liquid type hydatid cyst showing no visible cyst wall, clear fluid signals, no contents with diffusion restriction increased with increased b value and diminished signals in ADC map.
**Fig. 17:** Case IV: Coronal (A) and axial (B) T2 WI, ADC (C) and DWI in different b values 0,500,1000 (D1,2,3) respectively show typical features of liquid type hydatid cyst showing no visible cyst wall, clear fluid signals, no contents with diffusion restriction increased with increased b value and diminished signals in ADC map.
**Fig. 18:** Case IV: Coronal (A) and axial (B) T2 WI, ADC (C) and DWI in different b values 0,500,1000 (D1,2,3) respectively show typical features of liquid type hydatid cyst showing no visible cyst wall, clear fluid signals, no contents with diffusion restriction increased with increased b value and diminished signals in ADC map.
Fig. 19: Case V: Axial T1WI (A), T2WI fat suppression (B) revealed multiple hepatic cysts with the double layer cyst wall is more conspicuous in T1WI, proved to be type I hydatid cyst with visible cyst wall presented with multiple cyst. Axial T1WI, T2WI and coronal T2WI for the chest in the same patient revealed large left upper lobe cyst showing clear fluid signals and visible cyst wall in both T1 and T2 images.
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**Fig. 24:** Case VI: Right lobe subphrenic multi-vesicular hepatic hydatid cyst (type II) seen in axial T1WI (A), axial T2WI (B), coronal T2 (C) and coronal T2 fat suppression (D) images demonstrating both outer and inner membrane, internal daughter cysts and vesicles and clear fluid contents.
Fig. 25: Case VI: Right lobe subphrenic multi-vesicular hepatic hydatid cyst (type II) seen in axial T1WI (A), axial T2WI (B), coronal T2 (C) and coronal T2 fat suppression (D) images demonstrating both outer and inner membrane, internal daughter cysts and vesicles and clear fluid contents.

Fig. 26: Case VI: Right lobe subphrenic multi-vesicular hepatic hydatid cyst (type II) seen in axial T1WI (A), axial T2WI (B), coronal T2 (C) and coronal T2 fat suppression (D) images demonstrating both outer and inner membrane, internal daughter cysts and vesicles and clear fluid contents.
Fig. 27: Case VI: Right lobe subphrenic multi-vesicular hepatic hydatid cyst (type II) seen in axial T1WI (A), axial T2WI (B), coronal T2 (C) and coronal T2 fat suppression (D) images demonstrating both outer and inner membrane, internal daughter cysts and vesicles and clear fluid contents.
**Fig. 28:** Case VII Type II hydatid cyst (multi-vesicular type) noted as high signals fluid content in axial, coronal T2 WI (A),(B) and restricted diffusion of the fluid contents in axial DWI (C) with low fluid signals in ADC map image (D). The outer wall and internal septae exhibit low signals in both DWI and ADC.
Fig. 29: Case VII Type II hydatid cyst (multi-vesicular type) noted as high signals fluid content in axial, coronal T2 WI (A),(B) and restricted diffusion of the fluid contents in axial DWI (C) with low fluid signals in ADC map image (D). The outer wall and internal septae exhibit low signals in both DWI and ADC.
**Fig. 30:** Case VII Type II hydatid cyst (multi-vesicular type) noted as high signals fluid content in axial, coronal T2 WI (A),(B) and restricted diffusion of the fluid contents in axial DWI (C) with low fluid signals in ADC map image (D). The outer wall and internal septae exhibit low signals in both DWI and ADC.
**Fig. 31:** Case VII Type II hydatid cyst (multi-vesicular type) noted as high signals fluid content in axial, coronal T2 WI (A),(B) and restricted diffusion of the fluid contents in axial DWI (C) with low fluid signals in ADC map image (D). The outer wall and internal septae exhibit low signals in both DWI and ADC.

**Fig. 32:** Case VIII: Type III hydatid cyst (cyst with detached membrane) seen in axial T1WI (A), T2WI(B) and coronal T2 WI revealed internal detached and crumbled membrane involving right lobe liver and elevating overlying right lung base.
Fig. 33: Case VIII: Type III hydatid cyst (cyst with detached membrane) seen in axial T1WI(A), T2WI(B) and coronal T2 WI revealed internal detached and crumbled membrane involving right lobe liver and elevating overlying right lung base.
Fig. 34: Case VIII: Type III hydatid cyst (cyst with detached membrane) seen in axial T1WI (A), T2WI (B) and coronal T2 WI revealed internal detached and crumbled membrane involving right lobe liver and elevating overlying right lung base.
**Fig. 35:** Case IX: Axial T2 WI(A), DWI (B,C) and ADC map (D) showing type III hydatid cyst involving right hepatic lobe with detached floating membrane with restricted diffusion of the cyst fluid and non restriction of the internal membrane.
**Fig. 36:** Case IX: Axial T2 WI (A), DWI (B,C) and ADC map (D) showing type III hydatid cyst involving right hepatic lobe with detached floating membrane with restricted diffusion of the cyst fluid and non restriction of the internal membrane.
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Fig. 38: Case IX: Axial T2 WI(A), DWI (B,C) and ADC map (D) showing type III hydatid cyst involving right hepatic lobe with detached floating membrane with restricted diffusion of the cyst fluid and non restriction of the internal membrane.
Fig. 39: Case X Type III cyst with detached membrane seen in axial T1 (A), T2 TSE WI (B) and DWI (C). ADC (not shown here) revealed low signals of the internal fluid as well as the outer and internal detached membrane.

Fig. 40: Case X Type III cyst with detached membrane seen in axial T1 (A), T2 TSE WI (B) and DWI (C). ADC (not shown here) revealed low signals of the internal fluid as well as the outer and internal detached membrane.
Fig. 41: Case X Type III cyst with detached membrane seen in axial T1 (A), T2 TSE WI (B) and DWI (C). ADC (not shown here) revealed low signals of the internal fluid as well as the outer and internal detached membrane.
**Fig. 42:** Case XI: T1 (A) and T2 (B) axial fat suppression, ADC (C), DWI (D,E,F) in different b values 0, 500, and 1000 show typical features of hydatid cyst seen as hypointense T1, hyperintense T2, hypointense ADC and diffusion restriction in DWI with all b values.

**Fig. 43:** Case XI: T1 (A) and T2 (B) axial fat suppression, ADC (C), DWI (D,E,F) in different b values 0, 500, and 1000 show typical features of hydatid cyst seen as hypointense T1, hyperintense T2, hypointense ADC and diffusion restriction in DWI with all b values.
Fig. 44: Case XI: T1 (A) and T2 (B) axial fat suppression, ADC (C), DWI (D,E,F) in different b values 0, 500, and 1000 show typical features of hydatid cyst seen as hypointense T1, hyperintense T2, hypointense ADC and diffusion restriction in DWI with all b values.
Fig. 45: Case XI: T1 (A) and T2 (B) axial fat suppression, ADC (C), DWI (D,E,F) in different b values 0, 500, and 1000 show typical features of hydatid cyst seen as hypointense T1, hyperintense T2, hypointense ADC and diffusion restriction in DWI with all b values.
**Fig. 46:** Case XI: T1 (A) and T2 (B) axial fat suppression, ADC (C), DWI (D,E,F) in different b values 0, 500, and 1000 show typical features of hydatid cyst seen as hypointense T1, hyperintense T2, hypointense ADC and diffusion restriction in DWI with all b values.
Fig. 47: Case XI: T1 (A) and T2 (B) axial fat suppression, ADC (C), DWI (D,E,F) in different b values 0, 500, and 1000 show typical features of hydatid cyst seen as hypointense T1, hyperintense T2, hypointense ADC and diffusion restriction in DWI with all b values.
**Fig. 48:** Case XII Axial T1, T2, Coronal T1, T2, axial Diffusion WI and axial ADC revealed subcapsular subphrenic right lobe hydatid cyst with internal inhomogenities due to floating scolices and membranes with restricted diffusion and low signals in ADC map. Associated loculated right pleural effusion of homogenous fluid signals.
**Fig. 49:** Case XII Axial T1, T2, Coronal T1, T2, axial Diffusion WI and axial ADC revealed subcapsular subphrenic right lobe hydatid cyst with internal inhomogenities due to floating scolices and membranes with restricted diffusion and low signals in ADC map. Associated loculated right pleural effusion of homogenous fluid signals.

**Fig. 50:** Case XII Axial T1, T2, Coronal T1, T2, axial Diffusion WI and axial ADC revealed subcapsular subphrenic right lobe hydatid cyst with internal inhomogenities due to floating scolices and membranes with restricted diffusion and low signals in ADC map. Associated loculated right pleural effusion of homogenous fluid signals.
**Fig. 51:** Case XII Axial T1,T2, Coronal T1,T2, axial Diffusion WI and axial ADC revealed subcapsular subphrenic right lobe hydatid cyst with internal inhomogenities due to floating scolices and membranes with restricted diffusion and low signals in ADC map. Associated loculated right pleural effusion of homogenous fluid signals.

**Fig. 52:** Case XII Axial T1,T2, Coronal T1,T2, axial Diffusion WI and axial ADC revealed subcapsular subphrenic right lobe hydatid cyst with internal inhomogenities due to floating
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**Fig. 53:** Case XII Axial T1,T2, Coronal T1,T2,axial Diffusion WI and axial ADC revealed subcapsular subphrenic right lobe hydatid cyst with internal inhomogenities due to floating scolices and membranes with restricted diffusion and low signals in ADC map. Associated loculated right pleural effusion of homogenous fluid signals.
Conclusion

DWI may help in the detection and characterization of hepatic hydatid cysts as well as in the differential diagnosis of hydatid and simple cysts of the liver.

Images for this section:

**Fig. 1:** Case II: Coronal T2 (A) and Axial DWI (b values 0,500, 1000) showing proved simple left lobe ovoid shape hepatic cyst exerting homogenous T2 high signals with no cyst wall and restricted diffusion in b values 0,500 while no diffusion exerted in b value 1000
Fig. 2: Case II: Coronal T2 (A) and Axial DWI (b values 0,500, 1000) showing proved simple left lobe ovoid shape hepatic cyst exerting homogenous T2 high signals with no cyst wall and restricted diffusion in b values 0,500 while no diffusion exerted in b value 1000
**Fig. 3:** Case II: Coronal T2 (A) and Axial DWI (b values 0,500, 1000) showing proved simple left lobe ovoid shape hepatic cyst exerting homogenous T2 high signals with no cyst wall and restricted diffusion in b values 0,500 while no diffusion exerted in b value 1000
**Fig. 4:** Case II: Coronal T2 (A) and Axial DWI (b values 0,500, 1000) showing proved simple left lobe ovoid shape hepatic cyst exerting homogenous T2 high signals with no cyst wall and restricted diffusion in b values 0,500 while no diffusion exerted in b value 1000
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