CT Findings of Liver and Splenic Abscesses in Melioidosis: Comparison with Those in Non-Melioidosis

Vallop Laopaiboon MD, MSc*, Nittaya Chamadol MD*,
Hataichanok Buttham MD*, Wattana Sukeepaisarnjareon MD**

** Department of Radiology, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand*
*** Department of Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand*

Objective: *To compare the CT findings of liver and splenic abscesses in melioidosis (ML) with non-melioidosis (NML).*
Material and method: *CT (computed tomography) images of 47 patients with liver and splenic abscesses were retrospectively reviewed. The 28 patients with ML abscesses and 19 with NML abscesses were recruited into the present study. The sizes, shapes, distributions, margins, enhancement patterns and internal architectures of abscesses on CT images were evaluated and analyzed by Chi-square and Fisher exact tests.*
Results: *Seven and 6 ML patients had liver and splenic abscesses alone respectively, and 15 patients had combined liver and splenic abscesses. All NML patients had only liver abscesses. For liver abscesses, there were 3 ML and 13 NML patients with abscess size $\geq$ 3 cm. Eleven ML and no NML patients had abscesses < 3 cm (p = 0.00). The abscesses were multiple and discretely distributed in all 11 ML patients, but none in NML patients (p = 0.002). Seven ML and 13 NML patients had moderate to marked peripheral enhancement (95% CI: - 0.7, -0.01). All splenic abscesses (21 patients) found that B. pseudomallei was the causative organism. They were mostly smaller than 3 cm in size (85.71%), multiple (95.24%), and had no or minimal enhancement (85.71%).*
Conclusion*: The CT findings of liver abscesses that can help to differentiate ML from NML include sizes, distributions, and enhancement patterns. The features of ML splenic abscesses in the present study were small, multiple, with no or minimal contrast enhancement.*

Keywords: *Abscess, Liver abscess, Melioidosis, Splenic diseases, Tomography, X-ray computed*

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Melioidosis (ML) is an infectious disease with multisystem involvement. The causative organism is *Burkholderia pseudomallei*, a gram-negative bacilli, an environmental bacteria found in the wet soil. It is an important cause of morbidity and mortality in South East Asia and Northern Australia[1-11]. The committee of Infectious Disease Association of Thailand had classified melioidosis into six categories. 1) Disseminated septicemic melioidosis (DSM), in which the patients have positive blood culture and the evidence of disseminated infection of several organs. 2) Non-disseminated septicemic melioidosis (NSM, in which the patients have *B. pseudomallei* bacteremia and one or two foci of infection. 3) Localized melioidosis (LM), which usually affects one or a few organs, and the *B. pseudomallei* can be isolated from the clinical specimens, except blood. 4) Transient bacteremic melioidosis (TM), which the causative organism is isolated from the blood even though there are no abnormal clinical signs and symptoms suggesting melioidosis. 5) Probable melioidosis, which show the clinical symptoms compatible with melioidosis, without microbiological confirmation. These patients have high serology titer for *B. pseudomallei*. 6) Subclinical melioidosis, in which the patients are admitted with other conditions unrelated to melioidosis but have positive antibody for *B. pseudomallei*[1].

Correspondence to: Laopaiboon V, Department of Radiology, Faculty of Medicine, Khon Kaen University, 123 Group 16, Mittraparp Rd, Muang district, Khon Kaen 40002, Thailand. Phone: 043-348-389, Fax: 043-348-389. E-mail: laopaiboonv @yahoo.co.uk

Visceral abscess is one of the most common presentations in melioidosis[2]. The abdominal ultrasound study in patients with melioidosis had shown that 71% of the patients had single organ involvement; the rest of them had multiple organ involvement including 74% of splenic lesions, 46% of liver lesions, and 12% of kidney lesions. Among the multiple organ involvement group, multiple abscesses were more prevalent than single abscess[2]. The previous study of 81 patients in Khon Kaen Hospital (38 DSM, 39 LM and 4 NSM patients) revealed 37 patients with splenic abscesses, 16 patients with liver abscess,16 patients with combined splenic and liver abscesses, and three patients with combined splenic, liver and renal abscesses[3]. At present, there are several studies on ultrasound images of ML abscesses of the liver and spleen[2-10]. Although ultrasonography is the first choice of diagnostic tool to evaluate the melioidosis of liver and spleen, CT scan can further help when occult lesions are suspected in some patients[2,4,10,11]. Furthermore, CT scan may offer more specific information regarding the nature of certain lesions, such as, enhancement of abscess wall, calcification, and gas within an abscess[12]. The previous CT studies on ML liver and splenic abscesses were case reports[10,11]. It is necessary to distinguish ML abscess from NML abscess for effective treatment. The diagnosis by culture takes time. If the characteristics of the abscess on CT imaging can help in suggesting the cause of abscesses, it would be a valuable diagnostic tool, which is superior to ultrasonography in problematic cases.

The authors conducted an evaluation to compare the CT findings of liver and splenic abscesses in melioidosis group with those in non-melioidosis group.

Material and Method

Data collection

The authors retrospectively reviewed the CT images and medical records of 47 patients at Srinagarind Hospital between September 1998 and November 2005 who were diagnosed as ML and NML liver or splenic abscesses. The present study was approved by The Institutional Review Board of Srinagarind Hospital. The hard copy images from 28 patients (21 males and 7 females; mean age of 48 years) with ML abscesses and 19 patients (13 males and 6 females; mean age of 57 years) with NML abscesses caused by other organisms were evaluated (Table 1).

The diagnosis of ML was made by positive bacterial culture from blood, or pus from the livers or spleens, or other organs with or without positive serology in 17 patients. The remaining 11 ML patients were diagnosed by indirect hemagglutination antibody test (antibody titer $\geq$ 160) combined with clinical response to antimicrobial drug relatively specific for melioidosis (Table 2). The diagnosis of non-melioidosis was made by positive bacterial culture from blood or pus from the affected organs in 18 patients and indirect hemagglutination antibody test for *E. histolytic* in one patient (Table 3).

Imaging protocol

The CT scanning was performed using a multislice CT scanner (Somatom Plus 4 Volume zoom:

Table 1. The number and age of the patients with melioidosis and non-melioidosis

		Number of patients	Mean age (range), yrs
ML	Total	28	48 (24-71)
	Male	21	48 (24-71)
	Female	7	49 (38-60)
NML	Total	19	57 (24-80)
	Male	13	56 (24-80)
	Female	6	60 (30-78)

ML = melioidosis, NML = non-melioidosis

Table 2. Positive culture and serology results in the patients with melioidosis

Positive culture/serology	Number of patients
Pus	2
H/C	3
Pus + H/C	2
H/C+ IHA titer $\geq$ 160	2
Pus + IHA titer	3
H/C + Pus+ IHA titer $\geq$ 160	1
C/S from other organs (left thigh and pulmonary abscess)	2
C/S from other organs (urine and inguinal lymph node) + IHA titer	2
IHA Titer	11
Total	28

H/C = hemoculture, C/S = culture, IHA = indirect hemagglutination antibody

Table 3. Positive culture and serology results in the patients with non-melioidosis

Organisms	Number of patients		
	PUS	H/C	Pus+H/C
Klebsiellar spp.	6	5	0
Citrobactor spp.	1	0	0
Klebsiellar spp. and *Citrobactor* spp.	1	0	0
Klebsiellar spp. and *Streptococcus* spp.	1	0	0
MRSA	0	0	1
Actinomyces spp. and MRSA	1	0	0
Escherichia coli	1	0	0
Salmonella spp.	0	1	0
Entamoeba histolytica IHA titer	1	0	0
Total		19	

spp. = species, MRSA = methicillin-resistant *Staphylococcus aureus*, H/C = hemoculture, IHA= indirect hemagglutination antibody

Siemens, Forchherim, Germany) in 41 patients. The scan included liver and both kidneys or the whole abdomen with 2.5 mm collimation, a pitch of 0.25 with 8 mm reconstruction. The scanning parameters were 120 kV, 140 mA. Scanning time was 0.5 seconds.

A conventional helical CT scanner (Exvision/EX: Toshiba cooperation medical system division, Tokyo, Japan) was used in five patients. The scan included liver and both kidneys or the whole abdomen with 10 mm collimation and a pitch of 1. The scanning parameters were 120 kV, 100 mA. Scanning time was 1 seconds.

The contrast-enhanced scans were obtained after intravenous injection of 100 ml non-ionic water-soluble contrast media at a rate of 2.5-3 ml/sec. A 35 second and 70 second delay after initiation of contrast material injection was used for arterial and portovenous phases of the abdominal images with soft tissue window (window width, 300 HU; window level, 40 HU).

One patient underwent CT examination at a private hospital.

Image evaluation

The CT images of both ML and NML groups were evaluated in a blinded retrospective manner by two staff radiologists. If there were disagreement, the final interpretation would be reached by a consensus. The sizes of the abscess were classified as smaller than 3 cm, equal to or larger than 3 cm in diameter and variable sizes. The shapes of the abscess were classified as round, irregular and ovoid. The margins of the abscess were classified as well-defined, ill-defined, lobulated, well-defined and lobulated, ill-defined and lobulated. The distributions were classified as single and multiple abscesses. Multiple abscesses were subclassified as discrete, confluent, confluent and discrete, single and discrete distribution. Discrete distribution was defined as multiple scattered lesions separated by intervening normal parenchyma. Confluent lesion was defined as multiple lesions located close to each other. Confluent and discrete distribution was defined as one or multiple areas of confluent abscesses combined with small discrete abscesses. Single and discrete distribution was defined as a large solitary abscess combined with multiple small discrete abscesses. The enhancement pattern was classified as no or minimal enhancement, moderate/marked peripheral enhancement, and heterogeneous enhancement.

The internal architecture refers to internal septation and calcification in the abscesses. The internal septae that arranged orderly and radially like a wheel of the cart was designated as cart-wheel appearance.

The demographic data were expressed in mean and range. The findings of ML and NML groups were compared and analyzed by Chi-square and Fisher exact tests. A p-value of less than 0.05 was considered as statistically significant.

Results

Six of 28 ML patients and five of 19 NML patients had underlying DM (diabetic malitus) which was the most common underlying disease in both groups (Table 4).

Among 28 ML patients, seven had liver abscesses only, six had splenic abscesses only, and 15 patients had combined liver and splenic abscesses. All 19 NML patients had liver abscesses. No splenic abscess was identified in this group.

Table 5 shows the finding in liver abscesses. The abscess size was smaller than 3 cm in 11 of 22 (50%) ML cases (Fig. 1, 2), none in NML patients. Thirteen patients (68.4%) had NML liver abscesses equal to or larger than 3 cm (Fig. 3-5). There was a statistically significant difference in sizes of the abscesses between ML and NML groups.

The margins and shapes of the abscesses in both groups were not significantly different (Table 5).

Table 4. The underlying or associated diseases in the patients with melioidosis and non-melioidosis

Underlying/associated diseases	Number of patients	
	ML	NML
Diabetics mellitus	6	5
Hypertension	1	4
Thalassemia	4	0
Chronic renal failure	1	1
Anemia	2	0
Leukemia	1	0
Post cholecystectomy	0	4
Common bile duct stone	0	2

ML = melioidosis, NML = non-melioidosis

Discrete distribution was seen in 50% of ML patients, which was a statistically significant difference from the NML group (Table 5) (Fig. 1, 2).

For the characteristic of enhancement, 13 of 19 (68.4%) NML liver abscesses had moderate or marked peripheral enhancement (Fig. 3-5), and it was found in 31.81% of the ML group. This difference was statistically significant (95% CI; -0.7, -0.01) (Table 5).

There was no significant difference (p = 0139) in the frequency of internal septation between both groups (Table 5).

Splenic abscesses were caused by melioidosis in all of the presented patients (Table 6). The abscess sizes were less than 3 cm in 18 cases

Table 5. Comparison between the findings in liver abscess due to melioidosis and non-melioidosis patients

Findings			ML (n = 22)		NML (n = 19)		95% CI	p-value
			No.	%	No.	%		
Size		< 3	11	50.0	0	0	0.2, 0.8	0.000
		≥ 3	3	13.6	13	68.4	-0.8, -0.2	
		Variable sizes	8	36.4	6	31.6	-0.3, 0.4	
Margin		Ill-defined	2	9.1	1	5.3	-0.2, 0.2	0.116
		Well-defined	14	63.6	7	36.8	-0.1, 0.6	
		Lobulated	0	0	0	0		
		Well-defined + lobulated	6	27.3	11	57.9	-0.7, 0.1	
Distribution	Single	Single (S)	2	9.1	4	21.0	-0.5, 0.2	0.002
	Multiple	Discrete (D)	11	50.0	0	0	0.2, 0.8	
		Confluent (C)	5	22.7	9	47.4	-0.7, 0.2	
		C + D*	3	13.6	5	26.3	-0.5, 0.2	
		S + D**	1	4.6	1	5.3	-0.2, 0.2	
Enhancement		No + minimal	13	59.1	5	26.3	-0.02, 0.7	0.051
		Moderate/marked peripheral	7	31.8	13	68.4	-0.7, -0.01	
		Inhomogeneous	2	9.1	1	5.3	-0.2, 0.2	
Shape		Round	15	68.2	12	63.2	-0.4, 0.5	0.392
		Irregular	3	13.6	4	21.0	-0.4, 0.3	
		Ovoid	0	0	0	0		
		Round + ovoid	3	13.6	0	0	-0.1, 0.4	
		Irregular + ovoid	0	0	0	0		
		Irregular + round	1	4.6	2	10.5	-0.3, 0.2	
		Round + ovoid + irregular	0	0	1	5.3	-0.2, 0.1	
Septation		Absent	12	54.5	6	31.6	-0.1, 0.5	0.139
		Present	10	45.5	13	68.4	-0.5, 0.1	
Calcification		Absent	20	90.9	18	94.7	-0.2, 0.1	1.000
		Present	2	9.1	1	5.3	-0.1, 0.2	

* Confluence combined with discrete distribution

** Single large abscess combined with multiple small abscesses with discrete distribution

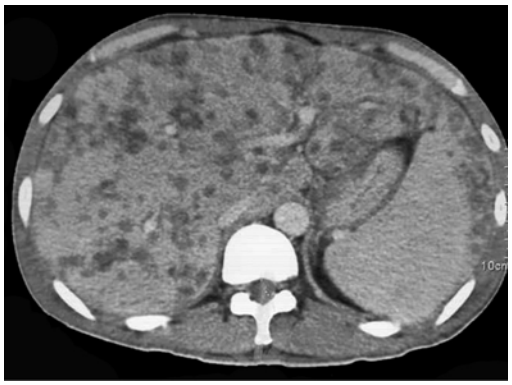

Fig. 1 A 39 year-old-man with melioidosis has multiple discrete liver abscesses without contrast enhancement

Fig. 2 A 44 year-old-woman with melioidosis has multiple splenic and few discrete liver abscesses (arrowheads) without contrast enhancement

Fig. 3 An 80 year-old-man with positive culture for *Citrobactor* spp. has multiple confluent liver abscesses (arrowhead) with internal septation and moderate peripheral enhancement

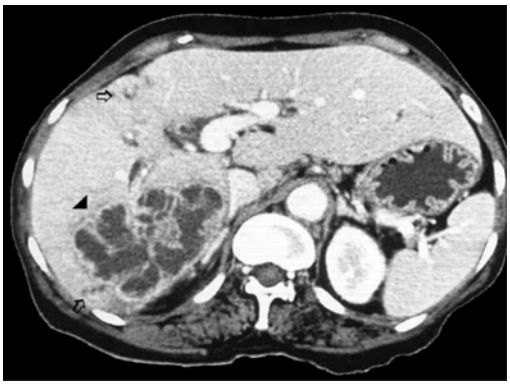

Fig. 4 A 64 year-old-woman with positive bacterial culture for *Klebsiellar* spp. has a large, marked peripheral enhanced liver abscess (arrowhead) with internal septation and few small discrete abscesses (open arrows)

Fig. 5 A 27 year-old-man with high level of *E. histolytica* titer has a well-defined and lobulated margin liver abscess (arrowhead) with moderate peripheral enhancement

(85.7%), well-defined margin in 15 patients (71.4%), round shape in 12 patients (57.1%), multiple and discrete distribution in nine patients (42.9%) (Fig. 2), and combined confluent and discrete distribution in eight patients (38.1%). Confluent splenic abscess was an uncommon picture (14.3%). No or minimal peripheral enhancement was found in 18 patients (85.7%) whereas it was 14.3% for moderate or marked peripheral enhancement. The majority of splenic abscesses were not calcified (80.9%) or had internal septation (80.9%) (Table 6).

The authors found cart-wheel appearance in the liver and the splenic abscesses in CT images of four ML patients (3 with liver abscesses, and one with splenic abscess) (Fig. 6-8). This appearance was also found in one NML liver abscess (Fig. 9).

Table 6. Findings in ML splenic abscesses of 21 patients

Findings			Number of paients	%
Size		< 3	18	85.71
		≥ 3	1	4.76
		Variable sizes	2	9.52
Margin		Ill-defined	2	9.52
		Well-defined	15	71.43
		Lobulated	0	0
		Well-defined + lobulated	4	19.05
Shape		Round	12	57.14
		Irregular	1	4.76
		Ovoid	0	0
		Round + ovoid	4	19.05
		Irregular + ovoid	0	0
		Irregular + round	3	14.29
		Round + ovoid + irregular	1	4.76
Distribution	Single	Single (S)	1	4.76
	Multiple	Discrete (D)	9	42.86
		C + D*	8	38.10
		Confluent (C)	3	14.29
		S + D**	0	0
Enhancement		No + minimal	18	85.71
		Moderate/marked peripheral	3	14.29
		Inhomogeneous	0	0
Calcification		Absent	17	80.95
		Present	4	19.05
Septation		Absent	17	80.95
		Present	4	19.05

* Confluence combined with discrete distribution

** Single large abscess combined with multiple small abscesses with discrete distribution

Discussion and Conclusion

In the present study, ML liver abscesses were commonly less than 3 cm in size and discretely distributed, whereas, NML liver abscesses were usually 3cm or larger than 3 cm in size with moderate to marked peripheral enhancement.

The difference in size between ML and NML liver abscesses was statistically significant. ML liver abscesses were usually less than 3 cm whereas NML liver abscesses were larger. This result was similar to the previous studies[2,3,7]. Wibulpolprasert B. reported that the most common ultrasonographic appearance of ML liver abscess were small discrete lesions (< 2 cm)[2]. The review by Mairiang et al[7] on the study of liver abscesses in Srinagarind Hospital showed that the abscess size in 64% of patients with other pyogenic infection and 17% of melioidosis had 5 cm or more in diameter on ultrasonographic findings. For the distribution of the liver abscesses, the statistically significant difference between ML and the NML groups was shown ($p = 0.002$). Liver abscesses from melioidosis commonly have discrete distribution, which were similar to the previous study on ultrasonographic findings[2]. Laopaiboon et al[8] described cart-wheel appearance abscess as the most specific finding in melioidosis. The authors found cart-wheel appearance abscesses in four ML patients (Fig. 6-8) and one NML patient (Fig. 9). The authors conclude that a cart-wheel appearance is highly suggestive but not specific for ML.

All patients with splenic abscesses in the present study were caused by melioidosis. The present study is limited because of small sample size. The prevalence of splenic abscesses in melioidosis being significantly higher than the abscesses caused by other bacteria had been supported by other researchers ($p < 0.05$)[4]. The result of the present study on multiple splenic abscesses coincides with

Fig. 6 A 32 year-old-man with positive culture for *Burkholderia pseudomallei* has multiple discrete liver abscesses that appear like cart-wheel (arrowheads)

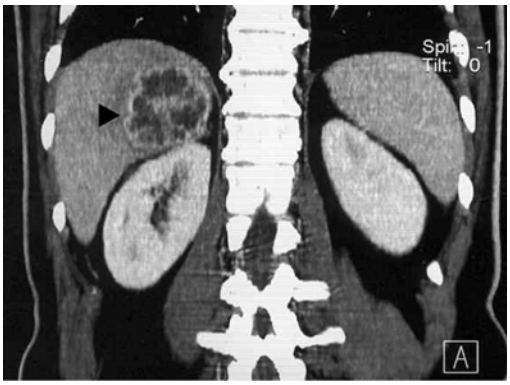

Fig. 9 A 55 year-old-man with positive bacterial culture for *Klebsiella* spp. also has cart-wheel appearance liver abscess (arrowhead)

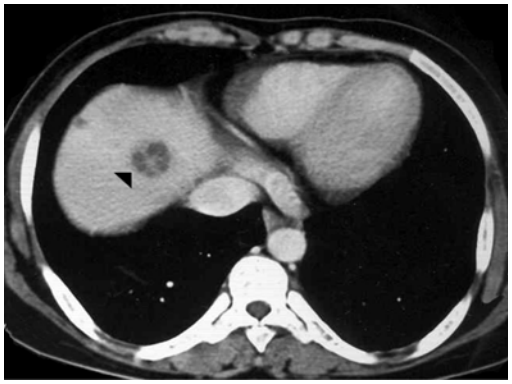

Fig. 7 A 38 year-old-woman with high antibody titer of melioidosis (Titer = 1280) has multiple discrete liver and splenic abscesses. The liver abscess shows cart-wheel appearance (arrowhead)

Fig. 8 A 54 year-old-woman with high antibody titer for melioidosis (Titer = 320) has discrete and confluent splenic abscesses with cart-wheel appearance (arrowheads)

the study by Sangchan et al[6]. Multiple abscesses less than 3 cm in diameter, no or minimal peripheral enhancement are the prominent pictures in ML splenic abscesses.

The previous studies on CT findings of liver and splenic abscesses from melioidosis were the case reports. Although retrospective data collection and small sample size are limitations of the present study, the significant findings in the present study may give clues to confidentially distinguishing ML from NML liver abscess on CT imaging.

In conclusion, the CT findings of liver abscesses that are helpful for differentiating melioidosis from non-melioidosis are sizes, distributions, and enhancement patterns. The liver abscesses that are less than 3 cm in size, multiple and discretely distributed tend to be melioidosis abscess. Three centimeters in diameter or larger, and moderate to marked enhancement liver abscesses tend to be caused by other organisms. Melioidosis should be suspected in patients with splenic abscesses.

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การศึกษาเปรียบเทียบลักษณะภาพเอกซเรย์คอมพิวเตอร์ระหว่างฝีในตับและฝีในม้ามของผู้ป่วย melioidosis และ non-melioidosis

วัลลภ เหล่าไพบูลย์, นิตยา ฉมาดล, หทัยชนก บุตรธรรม, วัฒนา สุขีไพศาลเจริญ

วัตถุประสงค์: เพื่อศึกษาเปรียบเทียบลักษณะภาพเอกซเรย์คอมพิวเตอร์ ระหว่างฝีในตับและฝีในม้ามของผู้ป่วย melioidosis และ non-melioidosis

รูปแบบการศึกษา: แบบสังเกตการณ์เปรียบเทียบ (Observation: analytical study)

วัสดุและวิธีการ: เป็นการศึกษาลักษณะภาพเอกซเรย์คอมพิวเตอร์ ย้อนหลังในผู้ป่วยที่เป็นฝีในตับและในม้าม จำนวน 47 ราย โดย 28 ราย เป็นฝีจาก melioidosis และ 19 ราย เป็นฝีจากเชื้ออื่นซึ่งได้ศึกษาเปรียบเทียบ รูปร่าง ขนาด การกระจาย ขอบของฝี enhancement patterns และลักษณะภายในของฝีโดยใช้สถิติ Chi-square และ Fisher exact test

ผลการศึกษา: ในผู้ป่วย melioidosis พบ 7 ราย เป็นฝีในตับอย่างเดียว 6 ราย เป็นฝีในม้ามอย่างเดียว 15 ราย พบเป็นทั้งฝีในตับ และในม้ามส่วนผู้ป่วย non-melioidosis ทุกคนเป็นฝีในตับอย่างเดียว สำหรับฝีในตับมีผู้ป่วย melioidosis 3 ราย และผู้ป่วยเป็นฝีจากเชื้ออื่น 13 ราย มีขนาดใหญ่กว่าหรือเท่ากับ 3 ซม. และผู้ป่วย melioidosis 11 ราย มีขนาดเล็กกว่า 3 ซม. ($p = 0.00$) ไม่มีผู้ป่วยเป็นฝีจากเชื้ออื่นมีขนาดเล็กกว่า 3 ซม. ลักษณะที่เป็นฝีหลายตำแหน่ง และกระจายในตับพบในผู้ป่วย melioidosis 11 ราย และไม่พบในผู้ป่วยเป็นฝีจากเชื้ออื่นในผู้ป่วย melioidosis 7 ราย และผู้ป่วยเป็นฝีจากเชื้ออื่น 13 ราย มี peripheral enhancement ปานกลางถึงมาก (95% CI: -0.7, -0.01) ทุกคนที่ เป็นฝีในม้าม 21 ราย เกิดจากเชื้อ B. pseudomallei infection ทุกคนโดยมีขนาดเล็กกว่า 3 ซม. ร้อยละ 85.71, เป็นหลายตำแหน่ง ร้อยละ 95.24, และมี enhancement น้อยหรือไม่มี ร้อยละ 85.71

สรุปการศึกษา: ลักษณะภาพเอกซเรย์คอมพิวเตอร์ที่ช่วยวินิจฉัยแยกโรคระหว่างฝีจาก melioidosis และ เชื้ออื่น ๆ ได้แก่ ขนาด การกระจาย และลักษณะ enhancement ฝีในม้ามจาก melioidosis ลักษณะขนาดเล็กหลายอันมี enhancement น้อยหรือไม่มี