Original Article

Ultrasound in Patients with Equivocal Inguinal Hernia

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Objective: To determine the correlation of ultrasound (US) diagnosis and further management in patients with equivocal inguinal hernia.

Materials and Methods: The Institutional Review Board approved the present retrospective study of US diagnosis and medical record in patients with equivocal inguinal hernia, who underwent US during a consecutive five-year period. The clinical indications and physical examinations were recorded, and the US diagnosis was evaluated. The correlation of the US diagnosis and further management (operative or non-operative management) was reviewed.

Results: One hundred twenty-seven patients, with 143 sides, were included of which 48 of 143 (33.6%) had visualized inguinal hernia by US and 45 of these (93.8%) were planned for surgery. The rest, 95 of 143 (66.4%), showed various findings such as solid lesions in 11 of 95 (11.6%), cystic lesions in 8 (8.4%), lymph nodes in 6 (6.3%), other findings in 22 (23.2%), and normal findings in 48 (50.5%). At step of treatment planning, 45 of 48 (93.8%) of patients with and 20 of 95 (21.1%) of those without visualized hernia were planned for surgery ($p<0.001$). At step of surgery, 30 of 48 (62.5%) of patients with and 22 of 95 (23.2%) of those without visualized hernia underwent surgery ($p<0.001$). At step of final diagnosis, the inguinal hernia was diagnosed in 30 of 32 (93.8%) and 8 of 84 (9.5%) in the groups with and without visualized inguinal hernia by US ($p<0.001$). US has sensitivity of 78.9%, specificity of 97.4%, accuracy of 91.4%, PPV of 93.8%, and NPV of 90.5% in patients with equivocal inguinal hernia.

Conclusion: US has an obvious role in diagnosis and guiding further management of patients with clinically equivocal inguinal hernia.

Keywords: Ultrasound, Equivocal hernia, Inguinal, Diagnosis

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Hernia was defined as a protrusion of a part or structure through the tissues normally containing it, either through an opening in the tissues or via stretching of the tissue wall[1]. External abdominal hernias are usually found in the inguinal region, where most are direct, indirect inguinal hernia, and femoral hernia[2].

Inguinal hernias are common, affecting one in four men in their lifetime. They are much less common in women with a lifetime risk of about 3%[3]. Approximate 96% of hernias are direct and indirect inguinal and 4% are femoral[4]. Direct and indirect inguinal hernias are more common in men (ratio 9 to 1), while femoral hernias are more common in women (ratio 4 to 1), particularly elderly women[5]. The prevalence of inguinal hernias increases with age, rising from a little under 1% in the 45- to 64-year age group, to 1.5% in the over 75-year-old age group[3]. Hernia may be associated with significant morbidity and even mortality[2].

The typical history is fluctuant, soft, and palpable mass[6], which may reduce spontaneously, requiring manual reduction or being irreducible[3]. Diagnosis historically has been by clinical methods, but more recently, imaging has played more of a role as a primary diagnostic tool in patients whose clinical

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examination may be normal or equivocal[7].

Many forms of imaging such as herniography, ultrasound (US), and magnetic resonance imaging (MRI) have been used for this purpose[8]. In the recent past, the herniography has been a reliable diagnostic tool with a high sensitivity (94%) and specificity (95%)[9]. However, this procedure is invasive and is associated with complication, ranging from visceral puncture, hematoma, and allergic reaction[10]. MRI has been advocated. It has a proven role for the investigation of inguinal pain and has shown to be superior to US in accuracy[11]. However, the cost of MRI compared to an US examination may also preclude its role as an initial investigation[8].

The US has more benefit as a non-invasive modality with accurate, dynamic imaging of soft tissue, and no risk of complication[12]. Two studies of Bradley et al showed high sensitivity, specificity, and positive predictive value of US findings in patients suspected of direct and indirect inguinal hernia, and femoral hernia compared with intra-operative findings[13,14]. In addition, the studies of Djuric-Stefanovic et al[15] and Robinson et al[16] showed great accuracy of US findings in each type of inguinal hernia compared with the intraoperative findings.

All hernias should be repaired to prevent hernia-related complications unless the patient has significant co-morbidity. Approximately 20% of the asymptomatic or minimally symptomatic hernias will become symptomatic later and require repair and around 1% will present with incarceration requiring emergency surgery[3]. Definitive data recommended as safe is not available, and it is for this reason that surgical repair of all inguinal hernias at diagnosis is recommended[17].

So far, there is no data regarding the correlation of US diagnosis and further management in patients with equivocal inguinal hernia provided in Thailand. Therefore, the authors conducted the present research project to evaluate this correlation.

Materials and Methods

Patient selection

The Institutional Review Board (IRB) approved the present retrospective study of US diagnosis and medical record in patients with equivocal inguinal hernia, who underwent US in the Department of Radiology of the authors' hospital between January 2009 and October 2013.

Inclusion criteria were all patients with history of or clinically suspected inguinal hernia but with normal or equivocal physical examination and underwent US study.

Exclusion criteria were patients with unavailable US diagnosis or incomplete medical record.

Radiologic assessment

The US was performed by either staff radiologist or radiology resident under supervision of staff. The US machines used were Philips iU22 (Andover, MA, USA) scanner. The transducers were high-frequency (12-5 MHz) linear array transducers available for superficial structures. Initial examination was performed with the patient in supine position, followed by valsava maneuver to increase abdominal pressure to identify transient hernias, as described by Jamadar et al[1]. Re-examination with the patient standing was also done if the evaluation in supine position did not reveal a hernia.

The US findings were classified into two groups, 1) visualized inguinal hernia including direct and indirect inguinal and femoral hernia, and 2) non-visualized inguinal hernia, which was divided into five subgroups, solid lesions, cystic lesions, lymph nodes, other findings, and normal appearance.

The inguinal hernias were defined as the direct visualization of a hernial sac containing bowel loops or omental content, or reducible hernial sac after positive cough or Valsalva maneuver[14], which was classified as follow:

1. Direct inguinal hernia[1]: the hernial sac was protruded from Hesselbach's triangle, which is bounded inferiorly by the inguinal ligament, medially by lateral margin of the rectus abdominis muscle and superiorly by inferior epigastric vessels.

2. Indirect inguinal hernia[1]: the hernial sac was protruded from area lateral to the inferior epigastric vessels and just above the inguinal ligament.

3. Femoral hernia[1]: the hernial sac was protruded from the femoral region, which is inferior to the inguinal ligament and medial to the femoral vein.

Clinical assessment

The processes were carried out by reviewing ultrasound diagnoses in official reports and medical records. Data collections included demographic information (age, gender, weight, side, history of ipsilateral inguinal hernia repair, and underlying disease), clinical presentation and clinical examination, and US diagnosis. Plan of management was reviewed from the medical record on the date of the follow-up and classified into operative management (e.g., inguinal hernia repair, excision, etc.) or non-operative management. The final diagnosis was reviewed

Table 1. Clinical features of the patients

Characteristic	n (%)
Age (year); mean±SD	55.5±15.2
Weight (kg); mean±SD	64.0±11.4
Sex (n=127 points)	
Male	80 (63.0)
Female	47 (37.0)
History of ipsilateral inguinal hernia repair (n=143 sides)	28 (19.6)
Side (n=143 sides)	
Right	87 (60.8)
Left	56 (39.2)
Clinical presentation (n=143 sides)	
Inguinal mass	92 (64.3)
Inguinal pain	39 (27.3)
Inguinal discomfort	12 (8.4)
Clinical examination (n=143 sides)	
Equivocal inguinal mass	113 (79.0)
Normal	30 (21.0)

SD=standard deviation

from the operative finding in the case of operation (surgical or histological diagnosis) or from medical record in the case of non-operative management after observation for at least three months (clinical diagnosis).

Statistical analysis

Data were analyzed by 1) mean and standard deviation for continuous data, 2) frequency and percentage for categorical data, 3) the association between factors related to outcome of interest was performed using Fisher's exact test, and 4) diagnostic ability of US comparing with the final diagnosis was presented as sensitivity, specificity, positive predictive value, negative predictive value, accuracy, likelihood ratio of positive and negative test, and receiver operating characteristic (ROC) area. All statistical analyses were done with Stata 12.0 software (College Station, Texas, USA). Statistical significance was set with a p-value of less than 0.05.

Results

One hundred thirty-one patients were included in the present study over a consecutive five-year period. Four patients were excluded due to unavailable medical record, resulting in 127 patients with 143 inguinal sides being included. Sixteen patients were suspected to have bilateral inguinal hernia. Table 1 shows clinical features of the patients. The age range of the patients was 16 to 84 (mean 55.5±15.2) years and weight range 45 to 109 (mean 64±11.4) kilograms. Eighty patients (63%) were male. Twenty-eight of the 143 sides (19.6%) had history of ipsilateral inguinal hernia repair. The most common clinical presentation was inguinal mass (64.3%), followed by inguinal pain (27.3%) and inguinal discomfort (8.4%). The most common finding by clinical examination was equivocal inguinal mass (79%), followed by normal finding (21%).

In Figure 1, of the 143 inguinal sides, inguinal hernia was visualized by US in 48 sides (33.6%). Forty-five out of 48 inguinal sides (93.8%) were planned for operative managements (inguinal hernia repair, either by open or laparoscopic method), but only 30 inguinal sides underwent operation at the time of the present report. The remaining 15 inguinal sides were waiting for operative schedule (n=8), lost follow-up, refused operation (n=6), or changed hospital (n=1). The remaining three (6.2%) inguinal sides were waiting for colonoscope (n=1) who had clinical presentation of inguinal pain associated with defecation, and observation (n=2) who had recent inguinal hernia repair for two days and had history of prostatic cancer post radical prostatectomy for two years.

In 95 of 143 (66.4%) inguinal sides, the inguinal hernia was not visualized by US (Figure 1). This group was divided into five subgroups (Table 2) according to US findings (Table 2). Twenty of 95 inguinal sides (21.1%) were planned for operative managements due to the US diagnosis of solid lesions (10/11, 90.9%), cystic lesions (4/8, 50%), lymph nodes (1/6, 16.7%), and other findings (5/22, 22.7%). However, only 18 of 20 inguinal sides underwent operations since two cases with US diagnosis of fibrotic nodule at the scar and intramuscular inguinal mass refused operation. The remaining 75 of 95 (78.9%) in this group were planned for non-operative management. However, four inguinal sides in this group underwent operations, two with US diagnosis of anterior abdominal wall weakness (n=2), one with US diagnosis as normal finding but subsequently developed clinical inguinal hernia and undergone inguinal hernia repair, and another one with US diagnosis of enlarged node developed inguinal pain at 7-months follow-up then underwent excision. In total, 22 of 95 inguinal sides (23.2%) of non-visualized inguinal hernia group underwent operations.

In Figure 1, all 30 operative sides of the visualized inguinal hernia group were confirmed

Table 2. Ultrasound diagnosis and plan of management in the cases of non-visualized inguinal hernia

Non-visualized inguinal hernia (n=95)	n	Plan of management	Pathological or surgical diagnosis
Solid lesion; n=11 (11.6%)			
Lipoma	5	Excision (n=4)	Lipoma
		No follow-up (n=1)	-
Intramuscular inguinal hernia[1]	2	Excision	Endometriosis externa (n=1)
Subcutaneous inguinal mass	1	Excision	Nodular fasciitis
Early abscess	1	Excision	Chronic abscess
Spermatic cord mass	1	Excision	Inguinal hernia with hemorrhagic cyst[2]
Fibrotic nodule at inguinal hernia repair scar[3]	1	Inguinal hernia repair	-
Cystic lesion; n=8 (8.4%)			
Ganglion cyst	1	Excision	Follicular lymphoma
Complex cyst	2	Excision	Chronic bursitis, recurrent femoral hernia[2]
Simple cystic mass	1	Excision	Femoral hernia[2]
Hydrocele	2	Clinical follow-up (n=1)	-
		No follow-up (n=1)	-
Epididymis cyst	1	No follow-up	-
Fluid collection	1	Clinical follow-up	-
Lymph nodes; n=6 (6.3%)			
Enlarged lymph node	1	Excision	Follicular hyperplasia
Lymphadenitis	1	No follow-up	-
Small inguinal lymph nodes	4	No follow-up	Reactive hyperplasia[4] (n=1)
Other findings; n=22 (23.2%)			
Bulging mesenteric fat	2	Clinical follow-up (n=1)	-
		No follow-up (n=1)	-
Abdominal wall weakness	7	Clinical follow-up (n=5)	Inguinal hernia[5] (n=2)
		No follow-up (n=2)	-
Hematoma	1	Clinical follow-up	-
OA hip	1	No follow-up	-
Surgical scar	1	Clinical follow-up	-
Undescended testis	1	No follow-up	-
Incisional hernia	3	Incisional hernia repair	Recurrent inguinal hernia[2] (n=1)
			Incisional hernia (n=2)
Varicocele or distended vein	5	Varicocelectomy (n=1)	Varicocele
		Clinical follow-up (n=1)	-
		No follow-up (n=3)	-
Focal fascial defect	1	Inguinal hernia repair	Recurrent inguinal hernia[2]
Normal appearance; n=48 (50.5%)	48	Clinical follow-up (n=14)	Inguinal hernia[5] (n=1)
		No follow-up (n=34)	-

OA=osteoarthritis

[1] One patient in this group refused operation, [2] Patients were accidentally found as intra-operative inguinal hernia, [3] Patient refused operation, [4] Patient presented with later inguinal hernia and was undergone lymph node excision, [5] Patients presented with later clinical inguinal hernia and were undergone inguinal hernia repair

intra-operatively as inguinal hernia. However, five sides of non-visualized inguinal hernia planned for operative management (US diagnosis of spermatic cord mass, simple cyst, complex cyst, focal fascial defect, and incisional hernia) (Table 2) were found intra-operatively to be inguinal hernias and underwent

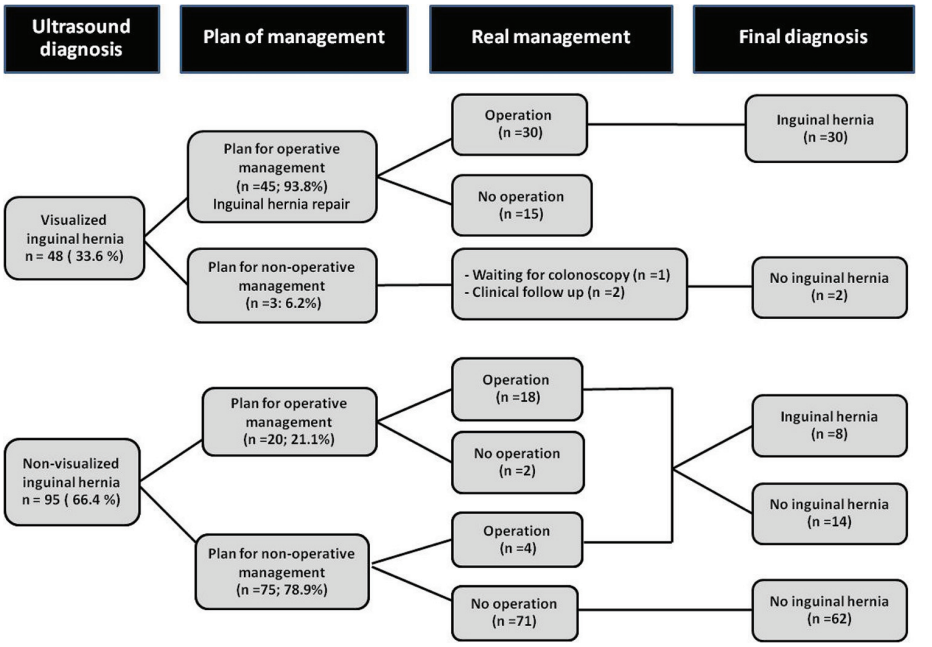

Figure 1. The diagram shows summary of patients with equivocal inguinal hernia who underwent ultrasound (n=143).

Table 3. Association of ultrasound diagnosis and management on patients with equivocal inguinal hernia

Operative management	Visualized inguinal hernia (n=48) n (%)	Non-visualized inguinal hernia (n=95) n (%)	p-value
Plan of management (n=143)	45/48 (93.8)	20/95 (21.1)	<0.001
Real management (n=143)	30/48 (62.5)	22/95 (23.2)	<0.001

Table 4. Association of ultrasound diagnosis and final diagnosis on patients with equivocal inguinal hernia

	Visualized inguinal hernia (n=32) n (%)	Non-visualized inguinal hernia (n=84) n (%)	p-value
Final diagnosis (n=116)			
Inguinal hernia	30/32 (93.8)	8/84 (9.5)	<0.001

inguinal hernia repair, and the last three sides were recurrence.

Twenty-seven of the 143 inguinal sides were excluded at the step of final diagnosis due to incomplete process (waiting for operative scheduling, lost follow-up, refused operation, or changed hospital), or incomplete clinical follow-up of at least three months. Therefore, the final diagnosis of inguinal hernia was found in 93.8% (30 of 32) and 9.5% (8 of 84) of visualized and non-visualized inguinal hernia groups, respectively.

The Table 3 and 4 shows statistically significant difference between visualized and non-visualized inguinal hernia and plan of management ($p<0.001$), real management ($p<0.001$), and final diagnosis of inguinal hernia ($p<0.001$). In the present study, US showed sensitivity of 78.9% (95% confidence interval [CI] 62.7 to 90.4), specificity of 97.4% (95% CI 91.0 to 99.7), positive predictive value (PPV) of 93.8% (95% CI 79.2 to 99.2), negative predictive value (NPV) of 90.5% (95% CI 82.1 to 95.8), accuracy of 91.4% (95% CI 84.7 to 95.8), and ROC area of 0.88 (95% CI 0.81 to 0.95) for diagnosis of inguinal hernia (Table 5).

Discussion

In the equivocal cases of inguinal hernias, imaging has a role in diagnosis to prevent hernia-

Table 5. Diagnostic value of ultrasound in detecting hernia

Ultrasound	Final diagnosis; n (%)	
	Inguinal hernia	No inguinal hernia
Visualized inguinal hernia	30 (78.9)	2 (2.6)
Non-visualized inguinal hernia	8 (21.1)	76 (97.4)
Total	38	78
Sensitivity (%)	78.9, 95% CI 62.7 to 90.4	
Specificity (%)	97.4, 95% CI 91.0 to 99.7	
Positive predictive value (%)	93.8, 95% CI 79.2 to 99.2	
Negative predictive value (%)	90.5, 95% CI 82.1 to 95.8	
Accuracy (%)	91.4, 95% CI 84.7 to 95.8	
Likelihood ratio of positive test [sensitivity/(1–specificity)]	30.8, 95% CI 7.8 to 122.1	
Likelihood ratio of negative test [(1–sensitivity)/specificity]	0.2, 95% CI 0.1 to 0.4	
ROC area [(sensitivity + specificity)/2]	0.88, 95% CI 0.81 to 0.95	

CI=confidence interval; ROC=receiver operating characteristic

related complications[7]. Many forms of imaging such as herniography, US, and MRI have been used for this purpose[8]. US has more benefit as a non-invasive modality with accurate result, being dynamic imaging, and no risk of complication[12]. The mean age of the patients was 55.5 years, corresponding to previous reports[8,13,18]. The major clinical presentation of the patients was inguinal mass (64.3%) similar to Bhosale et al[6]. This may suggest the demography that gets along well among various ethnics.

Thirty of the 48 patients (62.5%) with visualized inguinal hernia by US in the present study underwent operation, corresponded with 69.5% of Light et al[8] and 66% of Depasquale et al(18). This showed significant difference from the group without visualized inguinal hernia by US, which only 23.2% that underwent the operation ($p<0.001$). Therefore, US is an effective tool to guide treatment in this group of patients.

While 22 of the 95 patients (23.2%) patients without visualized inguinal hernia by US in the present study underwent the operation, the percentage is much higher than 4.6% of Light et al[8] and 3.4% of Depasquale et al[18]. This may be because many types of operation were included in the present study under the category of "surgery" (inguinal hernia repair, excision, repaired other types of hernia, and even varicocelectomy), while Light et al[8] and Depasquale et al[18] included only inguinal hernia repair.

Bradley et al showed sensitivity of 100%, specificity of 100%, and PPV of 98.5%[13,14], and Light et al had sensitivity of 94% and PPV of 73%, for US in diagnosis of hernia correlating with surgical findings[8]. Depasquale et al[18] also reported a PPV of 94%. Niebuhr et al[19] in their study of 4,951 clinical and US examinations of the groin area, recommended regular use of standardized US examination to ensure high-quality hernia treatment. Recently, Maisenbacher et al[20] in their retrospective study of 5-year period, addressed the high diagnostic value of US to have the sensitivity of 97%, specificity of 77%, PPV of 95%, and NPV of 87%. The present results went well with literature except the present result's sensitivity (78.9%), which is slightly lower than others. This can be explained by the difference in experience among the staffs in charge, because the present study is a routine-to-research type. Conversely, Alam et al[21] reported the sensitivity of US as 29% when compared to herniography. Robinson et al[22] in their systematic review and meta-analysis of the role of Radiology in the diagnosis of occult inguinal hernia, which defined as patients with symptoms suggestive of inguinal hernia but found to have normal clinical examination, reported that US has a sensitivity of 86% and a specificity of 77%. The same authors also mentioned that herniography had a sensitivity of 91% and a specificity of 83%, which was better than US. However, herniography is a relatively invasive procedure compared to US since it needs intraperitoneal injection of non-ionic contrast media and the patients have to expose to radiation.

The final diagnosis of inguinal hernia in the present study was confirmed in 30 of the 32 patients (93.8%), and eight of the 84 patients (9.5%), in the group with and without visualized inguinal hernia by US, respectively, ($p<0.001$). This result suggested that US has an important role in diagnosing the cases with equivocal inguinal hernia.

However, two of the 32 patients with visualized inguinal hernia by US did not show clinical hernia later on whereas eight of the 84 patients without visualized inguinal hernia by US were diagnosed as inguinal hernia at the time of follow-up, and three of eight were recurrence. From these results, the authors suggested that in the cases with equivocal inguinal hernia, US diagnosis combined with clinical follow-up will lead to a more accurate diagnosis, particularly in patients without visualized inguinal hernia by US.

There were some limitations in the present study. The first limitation related to the NPV in patients without visualized inguinal hernia by US. Since all patients in the present group did not undergo surgery, the NPV value may be inaccurate. Second, the number of studied people in the present study may not be

sufficient to evaluate hernia-related complication.

Conclusion

In patients with clinically equivocal inguinal hernia, US of the inguinal region has an important role to help diagnose inguinal hernia and guide treatment. The patients with visualized inguinal hernia by US were planned for operative management, underwent operation, and finally proved to have inguinal hernia in a significantly higher percentage than those without visualized inguinal hernia by US ($p<0.001$). Since certain cases without visualized inguinal hernia by US were diagnosed as inguinal hernia at the time of follow-up, the authors suggested that US diagnosis combined with clinical follow-up will lead to a more accurate diagnosis particularly in patients whom inguinal hernia was not visualized by US.

What is already known on this topic?

US has an important role in diagnosis of inguinal hernias.

What this study adds?

This study performed only in patients with equivocal history or symptoms of inguinal hernia, therefore emphasized the benefit of US in this entity. Further, this study evaluated the diagnostic values of US in routine-to-research basis which reflected situation in the real practice particularly in Thai population.

Conflicts of interest

The authors declare no conflict of interest.

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