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Radiology

Study on the Accuracy of Ultrasonography in the Assessment of Inguinal Hernias

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Abstract	Original Research Article

Introduction: Some hernias are clinically apparent and some are non-apparent and are a source of persistent groin pain. Groin swelling/lesion can be caused by different array of conditions involving different anatomical structures and having varied clinical presentation. This makes definitive diagnosis difficult for even the most experienced clinician. Ultrasonography can be invaluable in both localizing and characterizing type of inguinal hernia. ***Aim:*** to study the accuracy of ultrasonography in the assessment of inguinal hernias. ***Material and Methods:*** This was a special descriptive type of sensitivity and specificity study, conducted at tertiary care teaching hospital of medical college of western Maharashtra. Total 80 patients of groin swelling were studied after obtaining their written informed consent. Patients of all ages, irrespective of genders, who had incidental groin swelling, were included in the study. ***Results:*** The mean age of all participants was 44.25 ± 24.18 years. In our study out of 80 groin swellings, most common swelling diagnosed by USG was inguinal hernia (64). In this study, overall accuracy of ultrasonography to diagnose the hernia type (direct and indirect) was 88.57%. ***Conclusion:*** In present study ultrasonography showed high sensitivity and specificity as well as good accuracy; to differentiate the type of inguinal hernias.
Keywords: Inguinal Hernia, Ultrasonography, Sensitivity, Specificity.

INTRODUCTION

Some hernias are clinically apparent and some are non-apparent and are a source of persistent groin pain [1]. Surgical intervention has been considered as gold standard for the diagnosing and differentiating of both clinically apparent and non-apparent inguinal hernia [2,3]. However, this procedure is invasive and is associated with potential complications, including visceral puncture, haematoma at the injection site and allergic reaction to iodinated contrast agent. Variable complication rates from 0% to 5.8% have been reported [1-3]. Groin abnormalities can be caused by various diseases having a similar clinical presentation and clinical findings may be nonspecific in many cases, thus making the differentiation of pathology involved difficult or even impossible [4].

In cases in which the exact nature of a palpable mass in the groin is sometimes difficult to establish, and clinical diagnosis is obscured by obesity, previous surgery, radiation or trauma or in cases in which a herniated sac protrudes between muscle layers, ultrasonography can play an important role in the assessment of the correct diagnosis[4]. Although both CT and MRI may be extremely helpful in particular circumstances, ultrasound remains the initial imaging modality of choice. It provides inexpensive, noninvasive, radiation-free multiplanar imaging with excellent soft-tissue contrast and high spatial resolution. Real-time interaction with the patient allows practitioners to localize pain and to perform dynamic maneuvers [5].

Groin swelling/lesion can be caused by different array of conditions involving different anatomical structures and having varied clinical presentation. This makes definitive diagnosis difficult for even the most experienced clinician. Ultrasonography can be invaluable in both localizing and characterizing type of inguinal hernia. With this background, present study was conducted at tertiary care teaching hospital with aim to ascertain accuracy of ultrasonography in the diagnosis and differentiating the type of inguinal hernias.

MATERIALS AND METHODS

The present special descriptive type of sensitivity and specificity study was conducted at tertiary care teaching hospital of Western Maharashtra. Institutional Ethical Committees (IEC) permission was obtained before conducting a study. In this study total 80 patients of groin swelling were included after the explaining them the aim of the study and obtaining written informed consent. Study was carried out in the

ultrasonography section of department of Radiology of medical college for the period of two years. Patients of all ages, irrespective of genders, who had incidental groin swelling and came for abdominal pelvic ultrasonography, were included in the study. Those who were not willing to participate had only scrotal swelling was excluded from the study. In present study Siemens Acuson X500 ultrasonogram, 5-10 MHz Linear Array Transducer was used. Color and Power Doppler sonography was performed with optimized parameters.

In every patients history relevant to present study was obtained followed by clinical examination was performed. Examination of the groin in both men and women is performed with patient standing and the physician seated on a stool facing the patient [6]. The groin area was examined in oblique position with patient first at rest followed by active coughing to look for any bulge or an abdominal motion. In suspected groin hernias, the '3 finger' test was applied to differentiate between various types of groin hernias. The coughing test was used to distinguish between direct and indirect inguinal hernias. The patient was then asked to take supine position for ultrasound examination and change in the size of the swelling, if any, was observed. The results of the clinical examination were documented. Out of all study participants 64 patients who diagnosed of inguinal hernia on ultrasonography, were prospectively followed up till surgical exploration.

Statistical analysis

In present study, the following statistical methods were applied. For quantitative data, descriptive statistics viz. frequency, Mean, Standard deviation, Range was used. For qualitative data frequency and percentage were used. Data coding and entry was done in Microsoft Excel spread sheets and statistical analysis was done by using SPSS version 21 (Statistical Package for Social Sciences) software. The raw data was compiled, classified, presented in a tabulated manner to bring out important details. Chi square test was used to find out association and 5% level of significance considered significant ($P < 0.05$) Sensitivity and specificity, positive and negative predictive values and accuracy of clinical examination and ultrasonography were calculated to test their validity. The validity of clinical examination and ultrasonography were calculated with the help of OpneEpi (version 2), open source calculator-diagnostic test.

RESULTS

In this study 80 patients with groin swelling had participated. The Participants minimum and maximum age was 01 years and 83 years respectively. The mean age of all participants was 44.25±24.18 years. Age wise distribution of patients has shown in Graph 01. The maximum number of the patients (23.75%) were in the age group of 61 to 70 years. %). In this study predominance was noted for the male

gender. Out of 80 patients 91.25% (73) were male and 08.75% (07) were female patients. Swelling (71.55%) was reported as most common symptom by participants, followed by swelling with pain (20.0%) and pain only (08.75%) were the least reported symptoms. In present study, 51.25% (41) patients has groin swelling on right side while 42.25% (33) had lesion of their left side. Six (07.5%) groin swelling were bilateral.

In present study out of 80 groin swellings, most common swelling diagnosed by USG was inguinal hernia (64). Other groin swelling were of undescended testis (09), pseudoaneurysm of femoral artery (02), inguinal lymphadenopathy (02), encysted hydrocele of spermatic cord (01), hydrocele of the canal of Nuck (01) and funicular hydrocele (01). Out of 64 groin swelling 48.44% (31) and 42.19% (27) were on the right and left side respectively. Bilateral inguinal hernias found to be in 06 (09.37%) patients, so overall 70 groins with inguinal hernia were found. Distribution of the inguinal hernias according to their type and laterality has shown in table no 01. Out of 45 cases of indirect inguinal hernias 42 were unilateral and 03 were bilateral while in direct inguinal hernias 22 cases were bilateral and 03 cases were unilateral. In present study, out of 45 cases of indirect inguinal hernias, 28 contain omentum and 17 cases had bowel loop in their hernial sac; while out of 25 cases of direct hernias; omentum and bowel loop detected in 15 and 10 hernial sac respectively. Of the 45 indirect inguinal hernias diagnosed on surgery 42 were correctly diagnosed on ultrasonography while out of 25 direct hernias on surgery 20 were diagnosed correctly on ultrasonography (Table no 02).

Out of 26 direct inguinal hernias diagnosed on clinical examination, surgical findings confirmed the existence in 18 hernias. Thus there were 08 false positive direct hernias on clinical examination. Therefore the sensitivity of clinical examination in detecting inguinal hernias was 72% and the specificity was 82.22%. The positive predictive value was 69.23% and the negative predictive value was 84.09%. The overall accuracy of clinical examination to diagnosis the hernia type (direct and indirect) was 78.57% (Table 3A, 3B).

Out of 23 direct inguinal hernias diagnosed on ultrasonography, surgical findings confirmed the existence of in 20 hernias. Thus in the present study there were 03 false-positive direct hernias on ultrasonography. Therefore the sensitivity of ultrasonography in detecting direct inguinal hernias is 80% and the specificity is 93.33%. The positive predictive value is 86.96% and the negative predictive value is 89.36%. The overall accuracy of ultrasonography to diagnose the hernia type (direct and indirect) was 88.57% (Table 4A, 4B). The comparison of accuracy of diagnosis of hernia by clinical

examination and by ultrasonography investigation has shown in graph no 02.

Out of 70 hernias, the type of hernia was correctly diagnosed on both clinical examination and ultrasonography in 53 instances. In 06 hernias, both clinical examination and ultrasonography wrongly predicts the hernia type. In 02 instances, the hernia type

was correctly identified only on clinical examination whereas in 09 instances the hernia type was correctly identified only on ultrasonography. Thus out of 70 hernias, clinical examination identified correct the type of 55 (78.57%) inguinal hernias whereas ultrasonography identified correct type of 62 (88.57%) inguinal hernias (Table no 05).
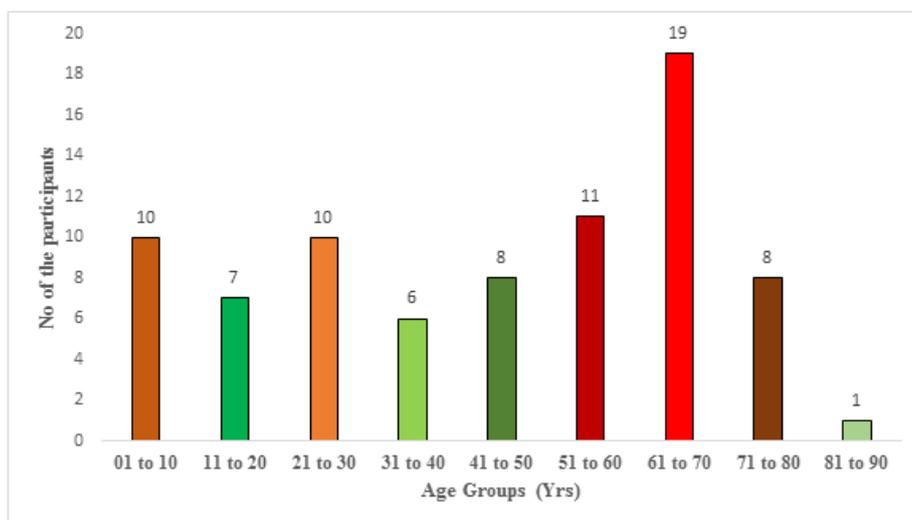
Graph-01: Age wise distribution of the participants

Table-01: Distribution of inguinal hernias according to type and locality

Sr. No.	Type of Inguinal Hernia	Laterality		Total
		Unilateral	Bilateral	
01	Indirect Inguinal Hernia	42	03	45 (64.28%)
02	Direct inguinal Hernia	22	03	25 (35.71)
	Total	64	06	70 (100%)

Table-02: Surgical vs. Ultrasonographic diagnosis of hernias

Type of Hernias	Diagnosis by Ultrasonography		Total hernias (Surgical diagnosis)
	Correct	Incorrect	
Indirect IH[*]	42	03	45
Direct IH[#]	20	05	25
Total	62 (88.57%)	08 (11.42%)	70 (100%)
*: Indirect inguinal hernia, #: Direct inguinal hernia			

Table-03A: Validity of clinical examination for the diagnosis of type of inguinal hernia

Surgical Findings / Clinical Diagnosis	Direct Inguinal Hernia	Indirect Inguinal Hernia	Total
Direct Inguinal Hernia	18	08	26
Indirect Inguinal Hernia	07	37	44
Total	25	45	70

Table-3B: Parameters of validity of clinical examination for the diagnosis of direct inguinal hernia

| Parameters	Estimate	Lower- Upper 95% Cls.	Method
Sensitivity	72%	52.42-85.72	Wilson Score
Specificity	82.22%	68.67-90.71	Wilson Score
Positive predictive value	69.23%	50.01-83.5	Wilson Score
Negative predictive value	84.06%	70.63-92.07	Wilson Score
Diagnostic Accuracy	78.57%	67.61-85.56	Wilson Score
*Results from OpenEpi, Version 2, Open source calculator-Diagnostic Test			

Table-04A: Validity of USG examination for the diagnosis of type of inguinal hernia

Surgical Findings / USG Diagnosis	Direct Inguinal Hernia	Indirect Inguinal Hernia	Total
Direct Inguinal Hernia	20	03	23
Indirect Inguinal Hernia	05	42	47
Total	25	45	70

Table-4B: Parameters of validity of Ultrasonography examination for the diagnosis of direct inguinal hernia

Parameters	Estimate	Lower- Upper 95% Cls.	Method
Sensitivity	80%	60.87-91.14	Wilson Score
Specificity	93.33%	82.14-97.71	Wilson Score
Positive predictive value	86.96%	67.87-95.46	Wilson Score
Negative predictive value	89.36%	77.41-95.37	Wilson Score
Diagnostic Accuracy	88.57%	79.04-94.09	Wilson Score
*Results from OpenEpi, Version 2, Open source calculator-Diagnostic Test			
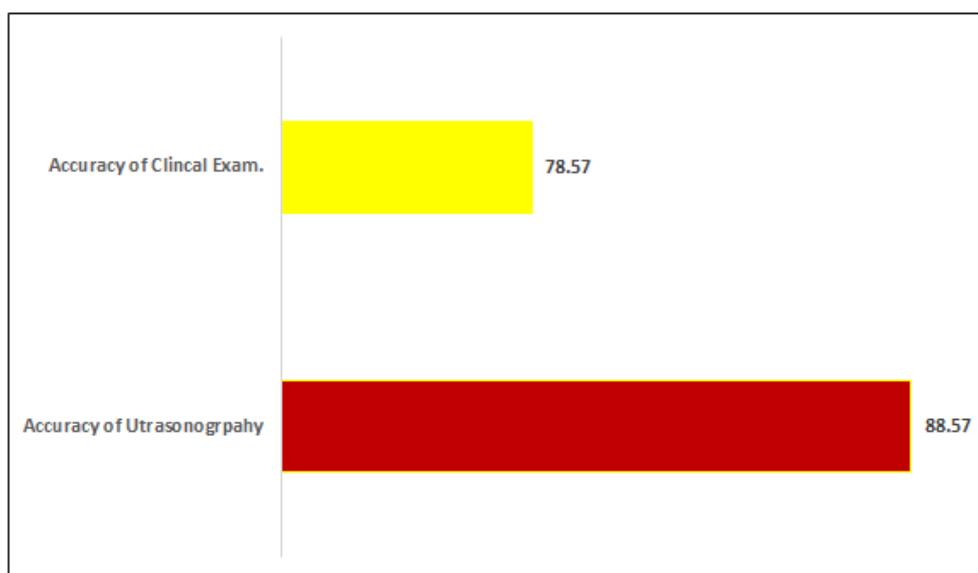
Graph-02: Accuracy of Clinical examination Vs Ultrasonography Diagnosis

Table-05: Clinical examination vs. Ultrasonographic investigation in diagnosing the type of inguinal hernia

Clinical Examination	Ultrasonography investigation		Total
	Correct Diagnosis	Missed Diagnosis	
Correct Diagnosis	53	02	55 (78.57%)
Missed Diagnosis	09	06	15 (21.43%)
Total	62 (88.57%)	08 (11.43%)	70 (100.0%)

DISCUSSION

A total of 80 patients of groin swelling who have undergone ultrasonography investigation were included in the study. The minimum and maximum age of the participants was 01 years and 83 years respectively. A male predominance was noted in the study participants with 73 (91.25%) male and 07 (08.75%) were female patients. The age ranges reported in other studies were Korenkov M *et al*. [7] (20-84 years.), Bradley M *et al*. [8] (28-90 years) and Kraft BM *et al*.[9] reported 20-92 age range. In present study about 80% of patients were in the age range of 21-83 years. In this study out of 80 groin swellings, 64 were inguinal hernia, 09 were undescended testis, and each two cases of pseudoaneurysm of femoral artery and inguinal lymphadenopathy were detected on ultrasonography. Remaining three swelling was of encysted hydrocele of spermatic cord, hydrocele of the canal of Nuck and funicular hydrocele.

Out of 64 patients of hernias 06 patients had bilateral hernias, So there were 64 patients with 70 inguinal hernias. In comprised of 58 males and 06 females, in the age range of 1 years to 83 years. The age ranges reported in other studies were Korenkov M *et al*. [7] (20-84 years.),

Bradley M *et al*. [8] (28-90 years) and Kraft BM *et al*.[9] reported 20-92 age range. In present study about 80% of patients were in the age range of 21-83

years. The incidence of inguinal hernias in the present study predominantly seen in males (90%). Bradley M *et al.* [8] and Kraft BM *et al.* [9] reported male incidence 89.3% and 92% respectively. The male predominance can be attributed to more amount of physical work done by males. In present study incidence of indirect inguinal hernias found to be more than direct type of hernia. In present study most of the hernias had omentum had omentum as the content. Study conducted by Yang DM *et al.* [10] also reported similar findings.

Till recently, physical examination of the inguinal canal was the only non-invasive way other than ultrasonography which could aid in the preoperative diagnosis of the type of inguinal hernia. In a study by Korenkov M *et al.* [7] the sensitivity and specificity of physical examination for diagnosing direct inguinal hernia was 75% and 100% respectively. In the present study the sensitivity and specificity of clinical examination for the diagnosing direct inguinal hernia was 72% and 82.22% respectively.

In present study out of 47 indirect inguinal hernias diagnosed on ultrasonography, surgical findings correlated in 42 hernias whereas 05 were found to be direct hernias. Of the 23 direct hernias diagnosed on ultrasonography surgical findings correlated in 20 hernias while 03 hernias were found to be of indirect type. Therefore the sensitivity of ultrasonography in detecting direct inguinal hernia was 80% and specificity was 93.33% the positive predictive value was 86.96% and the negative predictive value was 89.36%. Korenkov M *et al.* [7] reported sensitivity and specificity of ultrasonography in detecting inguinal hernia was 90% and 86% respectively. Bradley M *et al.*[8] reported sensitivity was 86% and specificity as 97%.

In present study we considered surgery as gold standard in diagnosing the type of hernia. When compared with the surgical findings, clinical examination correctly predicted the hernia in 55 out of 70 instances; whereas ultrasonography correctly predicted the hernia type in 62 out of 70 instances. Therefore the overall accuracy of clinical examination was 78.57% and that of ultrasonography was 88.57% in present study. Djuric Stanfanovi A *et al.* [11] and Kraft BM *et al.* [9] reported 96% and 94% accuracy of ultrasonography respectively in their study.

CONCLUSION
In present study ultrasonography showed high sensitivity and specificity as well as good accuracy; to differentiate the type of inguinal hernias.

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