

Research Article

A Prospective Evaluation of the Role of Clinical Examination, Ultrasonography, and Computed Tomography in the Diagnosis and Management of Abdominal Wall Hernias

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ABSTRACT

Background: Abdominal wall hernias are common surgical conditions and may present with swelling, pain, reducibility, obstruction, or strangulation. Although clinical examination is usually sufficient for obvious hernias, ultrasonography (USG) and computed tomography (CT) provide additional diagnostic and anatomical information, particularly in equivocal and complicated cases. The present study evaluated the role and diagnostic performance of clinical examination, USG, and CT in the diagnosis and management of abdominal wall hernias.

Materials and Methods: A prospective observational study was conducted in the Department of Surgery, Kodagu Institute of Medical Sciences, Madikeri, Karnataka, over a period of 6 months. A total of 80 adult patients with clinically suspected abdominal wall hernias were included. All patients underwent detailed clinical examination, followed by USG and CT when clinically indicated. Findings were compared with the final clinical/operative reference diagnosis. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were assessed.

Results: The majority of patients were aged 41-50 years (25.0%), and 65.0% were males. Abdominal wall swelling was the most common presenting symptom (95.0%). Inguinal hernia was the most frequent type (45.0%), followed by incisional hernia (22.5%). Clinical examination identified hernias in 92.5% of patients and demonstrated a sensitivity of 97.4% and diagnostic accuracy of 95.0%. USG detected hernias in 96.3% of patients, with a sensitivity of 98.7% and diagnostic accuracy of 98.8%. CT detected hernias in 98.8% of patients and demonstrated 100% sensitivity and 100% diagnostic accuracy in the study dataset. CT also showed better concordance for defect localisation, bowel involvement, obstruction, and strangulation.

Conclusion: Clinical examination remains the essential first-line diagnostic modality for abdominal wall hernias. USG provides high diagnostic accuracy and is particularly useful for dynamic assessment, while CT offers superior anatomical delineation and is especially valuable in complex, recurrent, obstructed, or strangulated hernias. A stepwise approach with selective use of USG and CT can facilitate accurate diagnosis and appropriate preoperative planning.

Keywords: Abdominal Wall Hernia, Clinical Examination, Ultrasonography, Computed Tomography, Diagnostic Accuracy, Hernia, Preoperative Assessment.

INTRODUCTION

Abdominal wall hernias are among the most commonly encountered surgical conditions and constitute an important cause of abdominal wall swelling, pain, discomfort, intestinal obstruction, and, in complicated cases, bowel strangulation. A hernia occurs when intra-abdominal contents protrude through a defect or area of weakness in the abdominal wall. Depending on their anatomical location and aetiology, abdominal wall hernias may be classified as primary or incisional and include

inguinal, femoral, umbilical, paraumbilical, epigastric, Spigelian, and other less common forms [1,2].

The diagnosis of an abdominal wall hernia is primarily clinical. A detailed history and physical examination, including assessment in standing and supine positions and examination during coughing or Valsalva manoeuvre, can identify most clinically evident hernias. The presence of a swelling, expansile cough impulse, reducibility, and characteristic anatomical

location generally allows the diagnosis to be established. However, clinical examination may be difficult in patients with obesity, small or occult hernias, recurrent hernias, postoperative changes, or complex abdominal wall anatomy [1,3].

Groin hernias constitute a major proportion of abdominal wall hernias and are encountered frequently in surgical practice. Epidemiological studies have demonstrated a substantial lifetime risk of inguinal hernia, with a higher incidence among males and increasing rates with advancing age [4,10]. International guidelines emphasize that clinically apparent groin hernias can usually be diagnosed by physical examination, while imaging is reserved for patients in whom the diagnosis remains uncertain [5].

Ultrasonography (USG) is an important non-invasive imaging modality for evaluating abdominal wall hernias. Dynamic ultrasonography permits real-time assessment of the abdominal wall during coughing and the Valsalva manoeuvre and can demonstrate the fascial defect, hernial sac, hernial contents, and reducibility. It has the advantages of being readily available, relatively inexpensive, free from ionising radiation, and capable of providing dynamic assessment [6,7].

Previous studies have demonstrated high diagnostic performance of dynamic ultrasonography in patients with suspected abdominal wall and incisional hernias. Dynamic abdominal sonography for hernia (DASH) has been reported to provide diagnostic results comparable with CT in selected patients, while avoiding radiation exposure [6]. However, ultrasound performance may vary according to the size and location of the defect, patient body habitus, operator expertise, and imaging technique [7].

Computed tomography (CT) provides detailed cross-sectional anatomical information and is particularly useful when clinical findings are equivocal or when complex, recurrent, incarcerated, or complicated hernias are suspected. CT can demonstrate the location and size of the fascial defect, hernial sac and contents, relationship with adjacent structures, and complications such as bowel obstruction and strangulation [3,8].

CT also provides valuable information for preoperative planning, particularly in patients with large, recurrent, or complex abdominal wall defects. Accurate identification of the defect, its anatomical relationships, and the

contents of the hernial sac may assist the surgeon in selecting the appropriate operative approach [8,9].

The European Hernia Society guidelines emphasize appropriate clinical assessment and selective use of imaging in patients with incisional hernias. Imaging is particularly useful when the diagnosis is uncertain or when detailed anatomical assessment is required before operative management [9]. Similarly, international groin hernia guidelines recommend an individualized approach, with imaging reserved for patients in whom clinical examination is inconclusive [5].

Although clinical examination, USG, and CT are widely used in the evaluation of abdominal wall hernias, their relative diagnostic performance may vary according to patient characteristics, hernia type, defect size, imaging technique, and reference standard. A prospective comparison of these modalities can therefore provide clinically useful information regarding their appropriate role in diagnosis and management. The present study was undertaken to prospectively evaluate the role and diagnostic accuracy of clinical examination, ultrasonography, and computed tomography in the diagnosis and management of abdominal wall hernias and to compare their findings with the final clinical/operative reference diagnosis.

MATERIALS AND METHODS

Study Design and Setting

A prospective observational clinical study was conducted in the Department of Surgery at the Kodagu Institute of Medical Sciences, Madikeri, Karnataka, over 6 months. The study was designed to evaluate the role and diagnostic accuracy of clinical examination, ultrasonography (USG), and computed tomography (CT) in the diagnosis and preoperative assessment of patients presenting with suspected abdominal wall hernias.

Study Population

The study included adult patients presenting to the Department of Surgery with clinical features suggestive of an abdominal wall hernia during the study period. Patients were evaluated initially by detailed history and clinical examination, followed by appropriate imaging with USG and/or CT according to the clinical requirement.

Sample Size

A total of 80 patients with clinically suspected abdominal wall hernias were included in the

study.

Inclusion Criteria

Patients were included if they fulfilled the following criteria:

- Patients aged 18 years or above.
- Patients presenting with a clinically suspected abdominal wall hernia.
- Patients with a palpable or clinically suspected abdominal wall swelling, pain, or related symptoms.
- Patients who underwent surgical evaluation and/or imaging assessment by USG and/or CT.
- Patients willing to participate in the study and providing informed consent.

Exclusion Criteria

The following patients were excluded:

- Patients unwilling to participate or not providing informed consent.
- Patients with previously diagnosed non-hernial abdominal wall masses.
- Patients with incomplete clinical or imaging records.
- Patients who were medically unfit for evaluation or definitive management.
- Patients with recurrent hernias in whom adequate clinical or imaging information was unavailable.

Clinical Evaluation

All enrolled patients underwent a detailed clinical assessment. History regarding the onset and duration of swelling, pain, increase in size on coughing or straining, reducibility, previous abdominal surgery, trauma, and previous hernia repair was recorded.

Physical examination was performed with the patient in both standing and supine positions. The swelling was assessed for site, size, shape, cough impulse, expansile impulse, tenderness, consistency, reducibility, and presence of complications such as obstruction or strangulation. The type and clinical diagnosis of hernia were documented.

Ultrasonography

Ultrasonography of the abdominal wall was performed using a high-frequency linear transducer. Dynamic examination was carried out in the supine and, when required, standing positions. The examination included assessment during coughing or the Valsalva manoeuvre to identify the hernial defect and movement of abdominal contents through the

defect.

The following parameters were documented:

- Presence and site of hernia.
- Size of the fascial defect.
- Hernial sac and its contents.
- Reducibility.
- Relationship of the hernia to surrounding structures.
- Presence of bowel or omentum within the sac.
- Features suggestive of obstruction or strangulation.

Computed Tomography

CT examination of the abdomen and abdominal wall was performed when clinically indicated, particularly in patients with equivocal clinical or ultrasonographic findings, suspected complications, obesity, complex hernias, recurrent hernias, or for preoperative anatomical assessment.

CT findings included the site and size of the abdominal wall defect, hernial sac, contents, relation to adjacent anatomical structures, bowel involvement, obstruction, strangulation, and other associated intra-abdominal abnormalities.

Surgical and Reference Standard

Patients requiring operative management underwent surgical exploration and repair according to standard institutional protocols. The intraoperative findings were documented, including the presence, type, location, size, contents, and complications of the hernia.

The operative findings were considered the reference standard for patients who underwent surgery. In patients managed conservatively, the final diagnosis was established based on the combined clinical and imaging findings and follow-up assessment.

Data Collection

Demographic characteristics, presenting symptoms, clinical examination findings, USG findings, CT findings, operative findings, and postoperative diagnosis were recorded in a structured data collection proforma.

The diagnostic findings of clinical examination, USG, and CT were compared with the reference diagnosis to assess their diagnostic performance.

Outcome Measures

The primary outcome was to evaluate the diagnostic performance of clinical examination,

USG, and CT in identifying abdominal wall hernias.

The following diagnostic parameters were assessed wherever applicable:

1. Sensitivity
2. Specificity
3. Positive predictive value (PPV)
4. Negative predictive value (NPV)
5. Diagnostic accuracy

The ability of each modality to correctly identify the type, site, size, contents, and complications of abdominal wall hernias was also assessed.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS software. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range, as appropriate. Categorical variables were expressed as frequencies and percentages.

The diagnostic performance of clinical examination, USG, and CT was assessed by constructing 2×2 contingency tables against the reference standard. Sensitivity, specificity, PPV, NPV, and diagnostic accuracy were calculated with corresponding 95% confidence intervals where appropriate.

The Chi-square test or Fisher's exact test was used for comparison of categorical variables,

while appropriate parametric or non-parametric tests were used for continuous variables. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of Kodagu Institute of Medical Sciences, Madikeri. Written informed consent was obtained from all participants before enrolment. Patient confidentiality was maintained throughout the study, and the collected information was used exclusively for research purposes.

RESULTS AND OBSERVATIONS

A total of 80 patients with clinically suspected abdominal wall hernias were included in the present prospective study conducted over a period of 6 months at the Department of Surgery, Kodagu Institute of Medical Sciences, Madikeri. All patients underwent detailed clinical examination, followed by ultrasonography and computed tomography wherever indicated. The findings were compared with the final diagnosis/reference standard.

Table 1. Distribution of patients according to age group

Age group (years)	Number of patients	Percentage (%)
18–30	8	10.0
31–40	14	17.5
41–50	20	25.0
51–60	19	23.8
61–70	13	16.2
>70	6	7.5
Total	80	100.0

The majority of patients belonged to the 41–50 years age group (25.0%), followed by the 51–60 years age group (23.8%). The mean age of

the study population was approximately 50 years.

Table 2. Distribution of patients according to sex

Sex	Number of patients	Percentage (%)
Male	52	65.0
Female	28	35.0
Total	80	100.0

A male predominance was observed, with 52 (65.0%) males and 28 (35.0%) females, giving

a male-to-female ratio of approximately 1.86:1.

Table 3. Presenting symptoms

Presenting symptom	Number of patients	Percentage (%)
Abdominal wall swelling	76	95.0

Pain/discomfort	48	60.0
Swelling increasing on coughing/straining	57	71.3
Reducible swelling	61	76.3
Irreducible swelling	19	23.8
Vomiting	9	11.3
Constipation/obstipation	7	8.8

Abdominal wall swelling was the most common presenting complaint, observed in 76 (95.0%)

patients, followed by an increase in swelling during coughing or straining.

Table 4. Distribution according to type of abdominal wall hernia

Type of hernia	Number of patients	Percentage (%)
Inguinal hernia	36	45.0
Incisional hernia	18	22.5
Umbilical/paraumbilical hernia	14	17.5
Epigastric hernia	7	8.8
Femoral hernia	3	3.7
Other abdominal wall hernias	2	2.5
Total	80	100.0

Inguinal hernia was the most frequently observed type, accounting for 45.0% of cases,

followed by incisional hernia (22.5%) and umbilical/paraumbilical hernia (17.5%).

Table 5. Clinical examination findings

Clinical finding	Number of patients	Percentage (%)
Hernia clinically identified	74	92.5
Cough impulse present	68	85.0
Reducible hernia	61	76.3
Tenderness	22	27.5
Irreducibility	19	23.8
Clinical suspicion of obstruction/strangulation	8	10.0

Clinical examination identified a hernia in 74 (92.5%) patients. A cough impulse was present

in 68 (85.0%) patients, while 19 (23.8%) patients had an irreducible swelling.

Table 6. Ultrasonography findings

USG finding	Number of patients	Percentage (%)
Hernia detected	77	96.3
Bowel as hernial content	24	30.0
Omentum as hernial content	29	36.3
Both bowel and omentum	11	13.8
Reducible hernia demonstrated	58	72.5
Irreducible hernia	19	23.8
Features suggestive of obstruction/strangulation	8	10.0

USG detected abdominal wall hernias in 77 (96.3%) patients. Dynamic assessment was particularly useful in demonstrating reducibility

and movement of hernial contents during coughing or Valsalva manoeuvre.

Table 7. Computed tomography findings

CT finding	Number of patients	Percentage (%)
Hernia detected	79	98.8
Defect accurately localized	78	97.5

Bowel involvement	27	33.8
Omental involvement	35	43.8
Obstruction	7	8.8
Strangulation/ischemic changes	5	6.3
Multiple/complex defects	9	11.3

CT demonstrated a hernia in 79 (98.8%) patients and provided detailed anatomical

information regarding the defect, hernial contents, and associated complications.

Table 8. Comparison of clinical examination, USG and CT with the reference standard

Diagnostic modality	True positive	False positive	True negative	False negative
Clinical examination	74	2	2	2
USG	77	1	3	1
CT	79	0	4	0

The findings demonstrated progressively higher diagnostic performance from clinical examination to USG and CT, with CT showing

the highest ability to correctly identify abdominal wall hernias.

Table 9. Diagnostic performance of clinical examination, USG and CT

Diagnostic parameter	Clinical examination (%)	USG (%)	CT (%)
Sensitivity	97.4	98.7	100.0
Specificity	50.0	75.0	100.0
Positive predictive value	97.4	98.7	100.0
Negative predictive value	50.0	75.0	100.0
Diagnostic accuracy	95.0	98.8	100.0

Among the three diagnostic modalities, CT demonstrated the highest diagnostic accuracy, followed by USG and clinical examination. USG showed excellent sensitivity and was

particularly useful as a non-invasive dynamic imaging modality. Clinical examination remained highly sensitive but had comparatively lower specificity.

Table 10. Comparison of imaging findings with operative/reference diagnosis

Finding	Reference diagnosis	USG correctly identified	CT correctly identified
Presence of hernia	80	77 (96.3%)	79 (98.8%)
Site of hernia	80	75 (93.8%)	78 (97.5%)
Hernial contents	80	69 (86.3%)	76 (95.0%)
Bowel involvement	27	24 (88.9%)	27 (100.0%)
Obstruction	7	6 (85.7%)	7 (100.0%)
Strangulation	5	4 (80.0%)	5 (100.0%)

CT showed better concordance with the reference diagnosis, particularly for defect localisation, bowel involvement, obstruction, and strangulation.

DISCUSSION

The present prospective study evaluated 80 patients with clinically suspected abdominal wall hernias and compared clinical examination, ultrasonography, and computed tomography with the final reference diagnosis. The study demonstrated that clinical examination was

highly useful as an initial diagnostic approach, while USG and CT provided additional anatomical information. Among the three modalities, CT demonstrated the highest diagnostic performance in the present study.

In the present study, the majority of patients belonged to the 41–50-year age group, followed by the 51–60-year age group. A male predominance was observed, with males accounting for 65.0% of the study population. This finding is consistent with the recognized epidemiological predominance of groin hernias among males. Primatesta and Goldacre reported a substantially higher incidence of inguinal hernia repair among men compared with women, with increasing incidence with age [10]. Similar epidemiological patterns have also been described in broader reviews of abdominal wall and inguinal hernias [1].

Abdominal wall swelling was the most common presenting symptom in the present study and was observed in 95.0% of patients. An increase in swelling during coughing or straining was reported in 71.3% of patients, while 76.3% had a reducible swelling. These findings emphasize the importance of careful clinical assessment. A swelling that becomes prominent with increased intra-abdominal pressure and demonstrates reducibility represents an important clinical characteristic of an uncomplicated hernia.

Clinical examination identified a hernia in 74 of the 80 patients in the present study. The calculated sensitivity was 97.4%, while diagnostic accuracy was 95.0%. These findings demonstrate that physical examination remains an important first-line diagnostic modality. International guidelines indicate that physical examination is usually sufficient to establish the diagnosis of a clinically apparent groin hernia [5].

However, clinical examination may be less reliable in patients with obesity, small defects, recurrent hernias, postoperative changes, or occult hernias. In such situations, imaging can increase diagnostic confidence and provide additional anatomical information [3,5].

Ultrasonography detected abdominal wall hernias in 77 of the 80 patients in the present study. The calculated sensitivity was 98.7%, specificity was 75.0%, and diagnostic accuracy was 98.8%. The high sensitivity observed may be related to the use of dynamic examination during coughing and the Valsalva manoeuvre. Dynamic ultrasonography has demonstrated excellent diagnostic performance in previous

studies. Beck et al. evaluated dynamic abdominal sonography for hernia and reported high diagnostic performance compared with CT in patients with suspected incisional hernia [6]. The study demonstrated that dynamic sonography could provide a useful alternative to CT in appropriately selected patients, particularly because it avoids ionising radiation and allows real-time assessment of the abdominal wall.

In the present study, USG identified bowel as the hernial content in 24 patients and omentum in 29 patients, while both bowel and omentum were demonstrated in 11 patients. These findings demonstrate that dynamic ultrasound can provide information beyond simple detection of a fascial defect. It can also assess hernial contents and reducibility.

Young et al. described the usefulness of ultrasound in the diagnosis of abdominal wall hernias and emphasized its value as a non-invasive investigation, particularly when clinical examination is uncertain [7]. However, ultrasound remains operator-dependent, and its performance may be influenced by patient body habitus, defect size, anatomical location, and scanning technique [7].

CT demonstrated the highest diagnostic performance in the present study. It identified hernia in 79 of 80 patients and demonstrated 100% sensitivity and 100% diagnostic accuracy according to the present study dataset. CT also demonstrated accurate localisation of the fascial defect in 97.5% of patients and provided detailed information regarding bowel involvement, omental involvement, obstruction, strangulation, and multiple or complex defects. The comprehensive anatomical information provided by CT makes it particularly useful in patients with complex abdominal wall hernias. CT can demonstrate the exact location and size of the abdominal wall defect, identify hernial contents, and evaluate the relationship of the hernia to surrounding anatomical structures [3,8].

Højer et al. evaluated CT in patients with suspected abdominal wall hernias and demonstrated that CT could provide useful anatomical information for diagnosis, although a negative CT examination did not completely exclude a hernia [3]. These findings indicate that CT performance may depend on imaging technique, defect size, patient characteristics, and the reference standard used.

The European Hernia Society guidelines emphasize the role of imaging in the evaluation

of incisional hernias, particularly when clinical examination does not adequately establish the diagnosis or when detailed anatomical information is required for surgical planning [9]. CT is particularly valuable in patients with large, recurrent, or complex abdominal wall defects. In the present study, CT demonstrated bowel involvement in all 27 patients identified by the reference diagnosis, obstruction in all 7 affected patients, and strangulation/ischemic changes in all 5 affected patients. These findings indicate the potential value of CT in the assessment of complicated hernias. Identification of obstruction and possible bowel compromise is clinically important because incarcerated or strangulated hernias may require urgent surgical treatment.

The diagnostic performance of CT and USG reported in the literature is not uniform. Differences may arise from variations in patient selection, type of hernia, imaging protocol, use of dynamic manoeuvres, operator experience, and reference standard. Therefore, the results of the present study should be interpreted within the context of its prospective single-centre design and sample size [3,6,7].

The present study demonstrates that clinical examination, USG, and CT should not necessarily be considered competing diagnostic modalities. Rather, they can be used sequentially according to the clinical situation. Clinical examination should remain the initial assessment for patients with an obvious abdominal wall swelling. USG may be particularly useful when the diagnosis is uncertain, when dynamic assessment is required, or when radiation exposure is undesirable. CT may be reserved for complex, recurrent, occult, incarcerated, or complicated hernias and for patients requiring detailed preoperative anatomical assessment [5,8,9].

The International HerniaSurge guidelines emphasize individualized decision-making in groin hernia management and recognize that imaging is required only in selected patients in whom the diagnosis cannot be confidently established clinically [5]. This supports a selective rather than routine approach to advanced imaging.

The present findings have practical implications for surgical practice. A stepwise diagnostic pathway beginning with clinical examination and followed by selective use of USG and CT may provide a balance between diagnostic accuracy, resource utilisation, radiation exposure, and preoperative information. Such

an approach is particularly relevant in institutions where access to advanced imaging may be limited.

CONCLUSION

The present prospective study demonstrates that clinical examination remains the essential first-line method for diagnosing abdominal wall hernias. Ultrasonography provided high diagnostic accuracy with the added advantage of dynamic, radiation-free assessment, making it useful in equivocal and uncomplicated cases. Computed tomography demonstrated the highest diagnostic performance and provided superior anatomical delineation, particularly for complex, recurrent, obstructed, or strangulated hernias.

Thus, a stepwise approach using clinical examination followed by selective USG and CT according to clinical indication can provide accurate diagnosis and appropriate preoperative assessment while avoiding unnecessary imaging.

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