

Diagnostic impact of using the semi-erect position in the evaluation of inguinal hernia with superficial sonography

Authors' Contribution:

A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
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ABSTRACT:

Introduction: The main cause of groin pain is inguinal hernia (IH). The most commonly used imaging test for diagnosis is sonography, which is also useful in distinguishing between indirect and direct hernias.

Aim: In this study, measurements were made with sonography in the semi-erect position (45°) in addition to the supine position and the effectiveness of this position in detecting the defect was investigated.

Material and methods: The IH cases diagnosed by ultrasound between March 2019 and October 2023 were evaluated retrospectively. According to the diameter of the defect in the supine position, the cases were divided into three groups: Group A (≤ 1.5 cm), Group B (1.5–3 cm), and Group C (≥ 3 cm). A total of 252 patients with unilateral IH were identified.

Results: For Group A, the mean value was 1.09 ± 0.23 (0.64–1.48) cm in the supine position and 1.28 ± 0.26 (0.67) cm in the semi-erect position ($p < 0.001$). For Group B, the mean value was 2.29 ± 0.29 (1.57–2.82) cm in the supine position and 2.41 ± 0.31 (1.65–2.94) cm in the semi-erect position ($p < 0.001$). For Group C, the mean value was 3.57 ± 0.23 (3.28–4.05) cm in the supine position and 3.62 ± 0.24 (3.32–4.10) cm in the semi-erect position ($p < 0.05$).

Conclusions: Superficial ultrasound, which provides reliable results in the diagnosis of IH, is an easily accessible modality. Unlike previous studies, this study was the first to examine the semi-erect position in IH patients. It showed that it is effective in determining the optimal diameter of the defect.

KEYWORDS:

inguinal hernia, semi-erect, ultrasound, valsalva

ABBREVIATIONS

CT – computed tomography

IH – inguinal hernia

MRI – magnetic resonance imaging

SPSS – Statistical Package for Social Sciences

US – ultrasound

INTRODUCTION

Inguinal hernia (IH), which occurs in approximately 5–10% of the population, is the most common cause of groin pain [1]. This clinical condition often requires surgical treatment. After a physical examination, almost all cases are referred to an ultrasound (US) laboratory for imaging [1, 2]. The first and most frequently used radiological method is superficial sonography. In addition to being easily accessible, inexpensive, and non-invasive, this method allows for a dynamic and comprehensive evaluation in the imaging area. It is very useful in evaluating the groin region and distinguishing between indirect and direct hernias [3, 4]. The Nyhus classification is used to surgically define hernias in this region and is divided into four main types. Using this classification, a distinction between indirect, direct, femoral, and recurrent hernias can be easily made; thus, a consensus has been reached regarding its use [5, 6].

Evaluation is routinely performed with superficial sonography in the supine position, though in a small number of cases the hernia is examined in the erect (sitting) position [7]. Small inguinal hernias that cannot be palpated during clinical examination are called “occult hernias” [8]. Sonography of the groin region is also very useful in making surgical decisions in occult hernias that are undetected on physical examination [9–11]. Other imaging modalities used in daily practice – computed tomography (CT) and magnetic resonance imaging (MRI) – are also less commonly used to diagnose IH, mainly in complicated hernias [12–14].

This study examined the effectiveness of the semi-erect position in detecting hernia with superficial ultrasound. In cases referred with a diagnosis of inguinal hernia, the semi-erect position at an angle of approximately 45° was evaluated in addition to the supine position.

MATERIAL AND METHODS

Subjects

The study was approved by the local ethics committee and it adhered to the Declaration of Helsinki. Patients aged ≥ 18 years who were referred to the radiology department with a diagnosis of

inguinal hernia and underwent superficial US between March 2019 and October 2023 were evaluated retrospectively. Informed written consent was available for all sonography procedures. The cases in which a linear probe was used during sonography procedures were included in the study (Fig. 1.). It was considered mandatory to perform measurements using the Valsalva maneuver in both the supine and semi-erect positions in the included cases (Fig. 2.). Only unilateral type I, type II, and type IIIa hernias according to the Nyhus surgical classification were included in the study. Patients with a history of IH surgery, varicocele, recurrent hernia, and bilateral IH were excluded from the study. Ultimately, 252 patients who met these criteria were included in the study.

Ultrasonography and Measurements

B-mod US imaging procedures were performed by a radiologist experienced in sonography and abdominal radiology. Measurements in the supine and semi-erect positions were performed in the axial plane, and a 3–13 MHz linear-array transducer (MyLab Seven, Genova, Italy) was used for all patients. The Valsalva maneuver was performed during measurements in both positions. The cases were divided into three groups according to the diameter of the defect in the supine position: Group A (≤ 1.5 cm), Group B (1.5–3 cm), and Group C (≥ 3 cm). The patients were also evaluated in terms of whether they were of indirect or direct type, as well as in terms of gender and age.

Statistical Analysis

The software program IBM SPSS ver. 18 (Chicago, Illinois, USA) was used for statistical analysis of the data. The Chi-square test was used to compare categorical variables, and descriptive methods (mean, minimum, maximum, and standard deviation, etc.) were used to determine the central distribution. The Kolmogorov–Smirnov test was used to determine whether the measurements obtained had a normal distribution. The t-test for independent samples and one-way ANOVA were used to compare the values of continuous variables. The paired-samples t-test was used to compare the means of two measurements across the groups. All continuous variables were also expressed as mean $\pm$ standard deviation. Based on the 95% confidence interval, $p < 0.05$ was considered statistically significant.

RESULTS

A total of 252 cases were included in the study: 141 (55.9%) men and 111 (44.1%) women. The youngest patient was an 18-year-old man, and the oldest was a 67-year-old woman. The mean age for all cases was 41.96 ± 13.82 , for men it was 38.15 ± 14.41 and for women 46.43 ± 11.89 (Tab. I.). IH was right-sided in 124 (49.21%) cases and left-sided in 128 (50.79%) cases. When evaluating the relationships between hernia side and gender and between hernia side and hernia type, no statistical significance was found ($p > 0.05$). The possible relationship between the hernia side and the measurements in both positions (supine and semi-upright) was also investigated and similarly no statistical difference was found ($p > 0.05$).

Direct hernia occurred in 85 (33.73%) cases and indirect hernia in 167 (66.27%) cases; these were types I, II, and IIIa according

to the Nyhus classification. The youngest case with the direct type was 22 years old, while the oldest was 67, with a mean age of 45.87 ± 15.47 years. The youngest patient with the indirect type was 18 years old and the oldest was 65, with a mean age of 40.29 ± 12.93 . The relationship between the measurement groups according to hernia type and supine position was also examined, and no statistical difference was observed ($p > 0.05$). In addition to this, the relationships between hernia type and age and hernia measurements was also examined, but no statistical significance was found ($p > 0.05$).

Based on the supine position, 91 (36.11%) cases belonged to Group A, 106 (42.06%) cases to Group B, and 55 (21.83%) to Group C. In the supine position, the smallest measurement for Group A was 0.64 cm, the highest measurement was 1.48 cm, and the mean measurement was 1.09 ± 0.23 cm. In the semi-erect position, the smallest measurement for the same group was 0.88 cm, the highest measurement was 1.67 cm, and the mean measurement was 1.28 ± 0.26 cm. In the supine position, the smallest measurement for Group B was 1.57 cm, the highest measurement was 2.82 cm, and the mean measurement was 2.29 ± 0.29 cm. In the semi-erect position, the smallest measurement for the same group was 1.65 cm, the highest measurement was 2.94 cm, and the mean measurement was 2.41 ± 0.31 cm. There was very high statistical significance when the measurements in the supine and semi-erect positions were compared for Groups A and B ($p < 0.001$). In Group C, the smallest measurement in the supine position was 3.28 cm, the highest measurement was 4.05 cm, and the mean measurement was 3.57 ± 0.23 cm. In the same group, the smallest measurement in the semi-erect position was 3.32 cm, the highest measurement was 4.10 cm, and the mean measurement was 3.62 ± 0.24 cm (Tab. II.). There was a statistically significant difference in this group when the measurements in both positions were compared ($p < 0.05$).

DISCUSSION

IH, one of the most common causes of groin pain, usually manifests as swelling and/or discomfort in the groin. Since a patient with IH may present only with pain, it is necessary to be careful in the differential diagnosis [1–3]. When diagnosing abdominal wall herniation, adductor sprain, tendinopathy, osteitis pubis, stress fracture, nerve entrapment, and testicular or other gastrointestinal pathologies should also be considered. Therefore, imaging is vital to reliably diagnosing and managing IH, planning appropriate treatment, and avoiding unnecessary surgery [15].

Typical complaints and/or physical examination alone are usually insufficient to detect an inguinal hernia. Various radiological techniques have been developed to address these challenges in the differential diagnosis of IH [16]. The first method described was herniography, which has been almost abandoned recently because it is an invasive technique that requires the use of intraperitoneal contrast injection and carries a serious risk of complications [4, 17]. Afterwards, sonography entered clinical practice, the advantage of this method being the non-invasive and dynamic evaluation of soft tissues. This method is inexpensive and non-invasive and allows for a comprehensive evaluation at the time of imaging. Even when the hernia cannot be palpated clinically, US has high sensitivity and positive predictive values in the diagnosis of IH [7, 11].

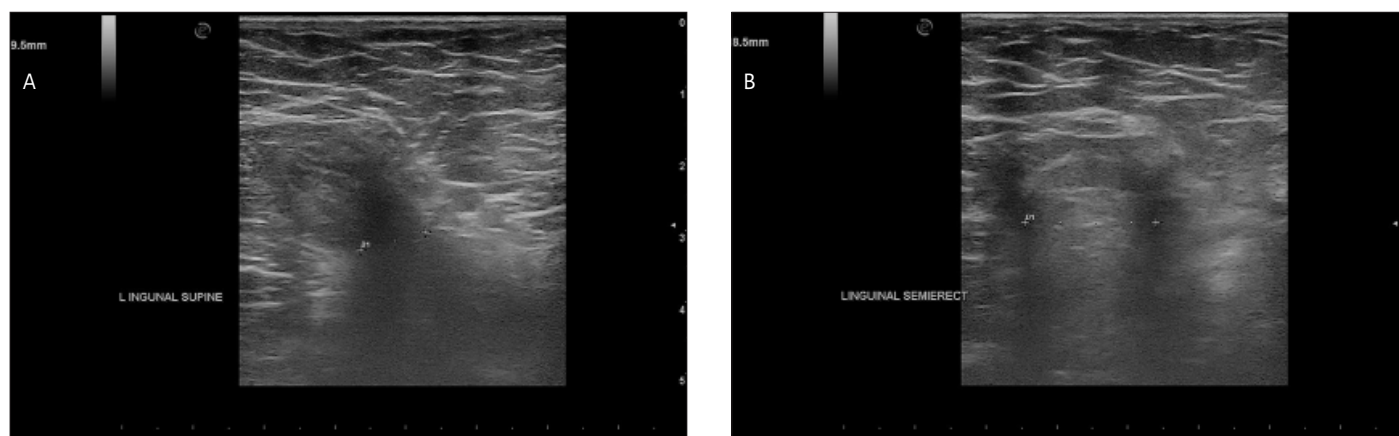


Fig. 1. A case of a 43-year-old man with a history of left indirect IH; Measurements were taken for the size of the defect in the (A) supine and (B) semi-erect positions. The values are observed in the upper-left corner for both images: there is a significant increase in the semi-erect position and the defect can be seen more clearly.

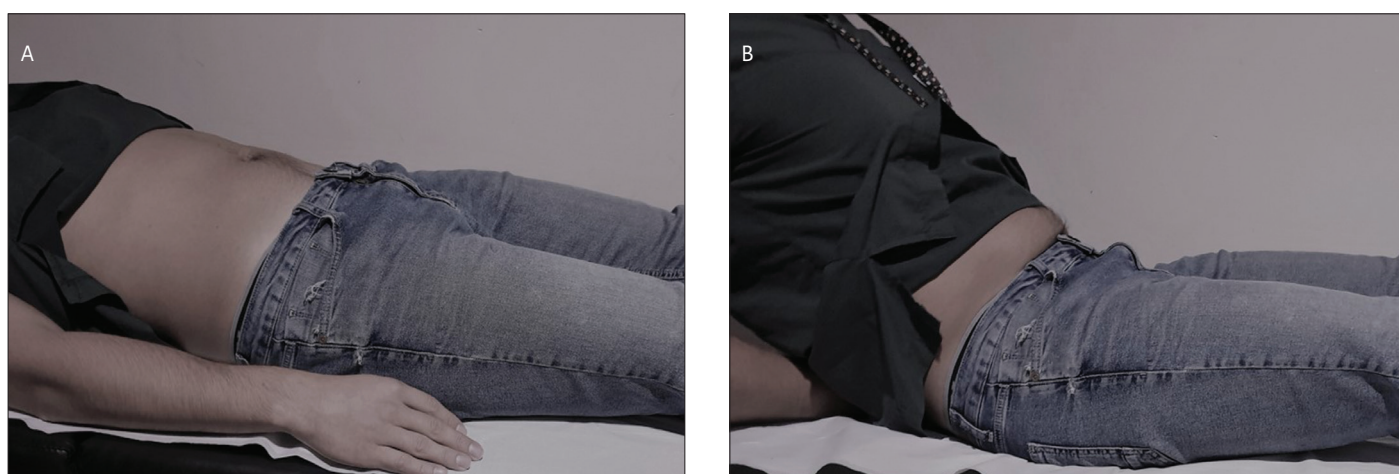


Fig. 2. A case of a 26-year-old man diagnosed with an IH; ultrasound measurements were taken in the (A) supine and (B) semi-erect (45°) positions.

In current practice, superficial sonography is the first and most preferred method for examining lesions in the groin area, and thus IH [18]. During superficial sonography, the Valsalva maneuver is performed, which increases the visibility of the hernia due to the hernial sac protruding further as a result of increased abdominal pressure [6–8]. Small IHs that are not palpable on clinical examination are referred to as occult, and US is helpful in detecting, monitoring, and deciding whether to operate on such hernias [9, 10]. On the other hand, CT and MRI are less commonly used as tools for post-ultrasound troubleshooting, especially in complicated and undiagnosed cases. Particularly in elderly men, peritoneal fatty hernia and direct inguinal hernia are often found incidentally on abdominal and pelvic CT scans [12, 14]. Although MRI is a radiation-free imaging modality that provides multiplanar imaging, it has disadvantages such as triggering claustrophobia, incompatible equipment, and not being readily available in every medical institution [13, 14, 16].

A study published by Shakil et al. revealed that inguinal hernias are caused by a defect in the abdominal wall and that IH is more common in men than in women. Although the diagnosis of IH in men is easy to make on the basis of a physical examination, sonography was found to be needed more frequently in women. The same study also demonstrated that US is useful when recurrent hernias, post-repair surgical complications, or other causes of groin pain, such as hydrocele are suspected. In addition, MRI was reported to have higher sensitivity and specificity than US and to be useful in the diagnosis of occult hernia in cases where clinical

suspicion is high despite negative ultrasound findings [2]. Jamadar et al. focused on the anatomy and sonographic evaluation of the inguinal region. They concluded that since the structures of the groin area are superficial, a 10-MHz or larger linear transducer will be effective, but a 7-MHz transducer may be needed in obese patients with larger body structures. First of all, the researchers stated that examination of the groin area should be performed when the patient is lying in the supine position. They also stressed that it is important to ask the patient to perform the Valsalva maneuver in order to increase abdominal pressure during superficial sonography to detect occult hernias. The authors concluded that US can thus distinguish IH from other inguinal hernias [3].

Piga et al. investigated the sensitivity and specificity of US, CT, and MRI in the diagnosis of inguinal hernia and its subtypes (direct and indirect). This systematic review included original studies in which patients with suspected inguinal hernias were diagnosed preoperatively with CT, MRI, or US and compared the diagnostic findings with surgical results or follow-up. As a result, the study determined that US had a higher sensitivity and specificity than the other modalities, while CT came second in the diagnosis of IH. However, another conclusion was to take into account that this high performance of US largely depends on the expertise of the operator and that US may be the preferred first imaging method when physical examination is inconclusive [4]. Wu et al. published a study stating the importance of sonography in inguinal hernias. According to this review, IH is the most common type of abdominal wall hernia and indirect IH is approximately twice as common as

Tab. I. Age and gender of patients.

GENDER	N	MINIMUM AGE	MAXIMUM AGE	MEDIAN AGE	STD. DEVIATION
Male	141	18	66	38.15	14.41
Female	111	26	67	46.43	11.89
Total	252	18	67	41.96	13.82

Tab. II. Measurements in supine and semi-erect positions.

TOTAL (N = 252)	GROUP A (N = 91)		GROUP B (N = 106)		GROUP C (N = 55)	
Position	Supine (≤ 1.5 cm)	Semi-erect	Supine (1.5–3 cm)	Semi-erect	Supine (≥ 3 cm)	Semi-erect
Minimum (cm)	0.64	0.88	1.57	1.65	3.28	3.32
Maximum (cm)	1.48	1.67	2.82	2.94	4.05	4.10
Mean (cm)	1.09	1.28	2.29	2.41	3.57	3.62
Std. deviation	0.23	0.26	0.29	0.31	0.23	0.24

direct IH. The same review also mentioned that CT and MRI can be used for diagnosis, but these methods are largely limited due to cost and availability. It has also been stated that US has emerged as the ideal imaging tool for diagnosing IH due to its advantages, such as portability and lack of radiation [7].

Another area of research in IH cases is occult hernias. Light et al. examined the role of sonography in this regard. In their study, a total of 297 patients were evaluated retrospectively and 116 patients were operated on. During surgery, a hernia was detected in 85 cases and no hernia was detected in 31 cases. Six patients underwent surgery due to persistent pain even though the ultrasounds were negative for IH; a hernia was detected in five cases. Overall, the correlation between ultrasound and surgical findings had a sensitivity of 94% and the positive predictive value of ultrasound used with clinical evaluation was 73%. It was concluded that US scanning alone is not effective in diagnosing IH when correlated with surgical findings, but can be a useful tool in diagnosing occult IH when combined with clinical evaluation [8]. Miller et al. compared the effectiveness of US, CT, and MRI in the diagnosis of occult IH. They examined retrospective records of surgical patients with groin and pelvic pain between 2008 and 2013. Fifty-nine patients were included and MRI correctly identified occult hernia in 10 of 11 cases (91%), especially among groins in which the diagnosis of hernia was missed on CT examination. The authors concluded that ultrasonography and CT could not reliably exclude occult IHs and that MRI should be performed as a definitive radiological examination [9].

Lorenzini et al. also evaluated the diagnostic importance of sonography in detecting occult IH, especially in patients with recurrent groin pain and a negative clinical examination. Over a three-year period, a total of 51 patients who were referred to the US clinic with a clinical suspicion of occult inguinal hernia were evaluated. While surgery was recommended for patients with positive superficial USG findings, further examination, CT or MRI, and other diagnostic tests were recommended for patients with negative US findings. All sonographic procedures were performed with the patient in a supine and erect position, while coughing and performing the Valsalva maneuver. IH was diagnosed by ultrasound in 20 cases and only one case was not diagnosed with a hernia during surgery (100% sensitivity and 96.9% specificity). According to these results, US can accurately diagnose inguinal hernias, and its use has been shown to be beneficial in patients with chronic groin pain due to suspected occult hernia [10]. In another study, Miller et al. evaluated

the reporting and interpretation of occult IH on CT and MRI. The researchers retrospectively analyzed CT and MRI examinations ordered for groin or pelvic pain over a 5-year period. At that time, operative findings were established as the gold standard for comparing radiology reports. A blinded radiologist was also asked to “review” the images. Many CT and MRI radiology reports for the detection of occult inguinal hernia were inaccurate and the “reviewer” radiologist was more than twice as likely to be accurate when re-evaluating the same images. As a result, it was concluded that in patients with groin or pelvic pain, CT or MRI images should be evaluated more carefully and repeatedly, especially if there is a strong clinical suspicion of an inguinal hernia [14].

Another issue regarding IH is postoperative pain and procedures to prevent it. One previous study mentioned that acute postoperative pain is a common problem after laparoscopic hernia repair. It was suggested that avoiding this or giving additional analgesia to patients with risk factors may be one option for reducing acute postoperative pain. Preoperative and intraoperative outcomes were recorded in 132 male patients and postoperative pain was assessed using the Visual Analog Scale. Time since hernia onset, as well as smoking and physical labor, were identified as possible risk factors for acute postoperative pain after minimally invasive inguinal hernia repair. It was concluded that additional analgesia may be beneficial in these patients [19]. Another study reported that tacks are often used during mesh fixation in laparoscopic IH repair, but may increase the risk of bleeding and chronic postoperative pain. Fixation with absorbable tacks was compared to fixation with cyanoacrylate glue, recently developed to reduce chronic pain. Cyanoacrylate adhesive has been demonstrated to be a safe option for mesh fixation in laparoscopic inguinal hernia repair, as it yields similar healing outcomes in early postoperative pain and chronic pain compared to absorbable tacks [20]. Similarly, Emral et al. evaluated chronic pain after Lichtenstein repair in patients with inguinal hernias. They compared the short- and long-term results of self-adhesive mesh and conventional polypropylene mesh and monitored 100 patients prospectively for an average of 36 months. The short- and long-term results of self-adhesive mesh and conventional polypropylene mesh were compared; no significant difference was found between the use of the two meshes, except for the duration of surgery [21].

There is a remarkable feature that distinguishes this study from previous ones. This is the first study in the literature in which IH

cases were evaluated in the supine position and at a 45° angle in the semi-erect position. There are only a few previous studies in which the upright position was used in addition to the supine position [3, 10, 22]. Since bedridden and elderly patients find it easier to move to the 45° position, this study evaluated the effectiveness of the semi-erect position. It also covered one of the highest sample sizes reported in the literature, involving 252 patients [23–25].

This study also had some limitations. The first is that all imaging procedures were performed only by a radiologist and differences between observers could not be evaluated. The second limitation is that the highest defect diameter among the available cases was 4.05 cm in the supine position, so evaluation of larger defects could not be made. The third limitation is that the patients with whom we can compare US measurements did not have additional imaging studies, such as CT or MRI of the groin. Another limitation is that there are no other studies which have evaluated IH using ultrasound in the semi-erect position with which we could compare our results.

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CONCLUSIONS

Sonography is the most frequently used imaging modality; it is easily accessible and provides reliable findings in the diagnosis of inguinal hernias. Due to its high sensitivity, it also appears to be useful in excluding occult inguinal hernias. Unlike previous studies, this study used the semi-erect position (45°) for the first time in IH cases and showed that it is effective in determining the optimal diameter of the defect. New studies with more patients are needed to evaluate the effectiveness of the semi-erect position in terms of its ease of use, especially in bedridden and elderly IH patients. Thus, it is believed that this position will be more useful in determining the defect diameter compared to the supine position.

ETHICAL APPROVAL

This study was approved by Istanbul Medipol University Ethics Committee (IRB: 2023/12/1021).

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