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Accuracy of ultrasonography in predicting contralateral patent processus vaginalis compared with laparoscopic findings in children

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Abstract

Objective The study aims to evaluate the usefulness of preoperative ultrasonography (US) at the internal inguinal ring level in predicting contralateral patent processus vaginalis (CPPV).

Methods This is a prospective study of patients who presented with unilateral inguinal hernia and underwent laparoscopic hernia repair and contralateral side exploration. The gender, age, initial presenting side, and the preoperative width of the low echoic region at the internal ring (WLIR) of the contralateral side that was determined using US and laparoscopic findings were recorded. The preoperative diagnosis of CPPV was considered if the WLIR is > 4 mm. We compared laparoscopic with US findings.

Results This study included 30 patients with a median age of 3.5 years (range, 25 days to 10 years), with 3 females and 27 males. The preoperative US and laparoscopic diagnoses of the contralateral side were concordant in 19 (63.3%) and discordant in 11 (36.6%) patients. US showed a sensitivity of 50.00%, specificity of 72.22%, and accuracy of 63.3% in diagnosing CPPV.

Conclusions Measuring the WLIR by US was inadequate for an accurate CPPV diagnosis in our study. Therefore, more distinctive US criteria are required for a proper CPPV diagnosis.

Keywords Inguinal hernia, Ultrasonography, CPPV, Child

Background

Inguinal hernia is the most reported pediatric surgical condition with an incidence range of 0.8–4.4% in children, and 16–25% in preterm infants [1]. Approximately 80% of inguinal hernia is unilateral. However, 7–15% of children develop a hernia on the contralateral side after unilateral hernia repair (metachronous contralateral inguinal hernia [MCIH]) [2, 3]. MCIH development will necessitate a second operation and anesthesia. MCIH

will develop on top of an asymptomatic CPPV which will be inadequately detected with history and physical examination [4–6]. Many methods, such as herniography, diagnostic pneumoperitoneum, intraoperative transperitoneal probing using a choledochal dilator, intraoperative laparoscopy, and ultrasonography (US), have been used to detect CPPV [6]. The US has the advantage of being a dynamic and non-invasive tool, which does not use ionizing radiation [7]. The study aims to evaluate the usefulness of preoperative US at the internal inguinal ring level in predicting CPPV. The current study aimed to prospectively determine CPPV incidence in patients who presented with unilateral oblique inguinal hernia (OIH) and determine the accuracy of US in detecting CPPV through the width of the low echoic region at the internal ring (WLIR) measurement.

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Methods

This study prospectively included 30 pediatric patients with unilateral OIH less than 13 years of age. Patients with unilateral or bilateral undescended testis, bilateral OIH and/or hydrocele, history of surgical procedure at the contralateral groin, or contraindications for laparoscopy were excluded.

After history taking and physical examination, an inguinal US study was performed while the patient was in the supine position and during rest using a 7.5-MHz transducer. We directly placed the probe at the internal ring (mid-inguinal point). The internal ring was scanned through a long-axis view that is oriented parallel to the inguinal ligament. We identified the external iliac and the inferior epigastric vessels. The internal inguinal ring is a hypoechoic region in the posterior wall of the inguinal canal immediately lateral to the inferior epigastric vessels. We measured the WLIR of the contralateral side (Fig. 1). Preoperative CPPV diagnosis was considered if the WLIR was > 4 mm. All patients underwent presenting side laparoscopic repair and contralateral side exploration (Fig. 2). We compared laparoscopic findings with US findings.

Statistical methods

Data were coded and entered using the Statistical Package for the Social Sciences version 26. We summarized data using mean, standard deviation, median, minimum, and maximum in quantitative data and frequency (count) and relative frequency (percentage) for categorical data. Standard diagnostic indices, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic efficacy, were calculated as



Fig. 1 Ultrasonographic finding of the left-sided internal ring in a one-month-old male patient presented with right OIH. A Width of the internal ring of 4.5 mm. B Inferior epigastric vessels. C External iliac vessels



Fig. 2 Laparoscopic findings of the same patient showed the left-sided patent processus vaginalis

described by Galen RS [8]. Quantitative variables were compared using the non-parametric Kruskal–Wallis and Mann–Whitney tests [9]. Categorical data comparison used the chi-square (χ^2) test. The exact test was used instead when the expected frequency was < 5 [10]. *P* values of < 0.05 were considered statistically significant.

Results

Our study included 30 patients with a median age of 3.5 years (range 25 days to 10 years). We grouped them into 3 groups according to age (Table 1). Three (10%) were females and 27 (90%) were males. One case only was preterm.

Right-sided OIH was observed in 19 (63.3%) cases while 11 (36.7%) presented with left-sided OIH. Preoperative WLIR measurement with the US was done for all patients. The preoperative CPPV diagnosis was considered if the WLIR is > 4 mm. Presenting side laparoscopic repair and contralateral side exploration were performed for all patients. In our cohort, laparoscopic exploration showed that 11 patients had CPPV (36.6%) (Table 2).

We used the laparoscopic findings for diagnostic standards. Among the 30 patients, 6 were correctly diagnosed with CPPV in the US with an accuracy of 63.33% (Tables 3 and 4).

Table 1 Count and percentage of patients according to age group

		Count	%
Age group	< 2 years	10	33.3%
	2–5 years	15	50.0%
	> 5 years	5	16.7%

Table 2 Correlation between presenting side and laparoscopic findings of the contralateral side

		Presenting side				P value
		Right side		Left side		
		Count	%	Count	%	
CPPV in laparoscopic Exploration	Yes	8	42.1%	3	27.3%	< 0.001
	No	11	57.9%	8	72.7%	

CPPV contralateral patent processus vaginalis

Table 3 Results of ultrasonography in diagnosing CPPV compared to laparoscopic findings

Results	True positive	True negative	False-positive	False-negative
Number of cases	6	13	5	6

Table 4 Sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of ultrasonography in diagnosing CPPV in 30 patients compared to laparoscopic findings

Indexes	Negative predictive value	Positive predictive value	Sensitivity	Specificity	Accuracy
%	68.42%	54.55%	50%	72.2%	63.33%

No statistically significant correlation was found between age, US WLIR, and laparoscopic findings of the contralateral side (Table 5).

Discussion

Contralateral groin management during unilateral hernia repair is controversial. Approximately 10% of these patients will develop MCIH later on with the need to have a second operation and anesthesia. Contralateral groin exploration is frequently used to detect CPPV, but it carries the risk of operative complications, and closing the processus vaginalis will be useless [11]. This

will help the surgeon decide whether to explore the contralateral groin if the US could accurately predict the presence of CPPV. Our study measured the WLIR during rest, and we used > 4 mm to diagnose PPV (patent processus vaginalis). Chen et al. [4], Chou et al. [12], and Kervancioglu et al. [13] accepted the same values for diagnoses. All patients underwent a contralateral side laparoscopic exploration, which showed a 36.6% CPPV incidence, 42.1% with a right-sided hernia, and 27.3% with a left-sided hernia. CPPV incidence in our series is similar to Shehata et al. (35.8%) [14] and lower than Zhoa et al. (51%) [15]. At laparoscopy, Zhoa et al. [15] and Schier et al. [16] reported a higher CPPV incidence in left-sided hernia compared to right-sided hernia (53.4% vs. 50.2% and 23% vs. 22% respectively). Our study revealed a higher CPPV incidence in patients who presented with a right-sided OIH and this may be because of the small sample size.

In our study, the preoperative US diagnosis and the contralateral side laparoscopic diagnosis were concordant in 19 (63.3%) patients and discordant in 11 (36.6%) patients. US showed a sensitivity of 50.00%, specificity of 72.22%, and accuracy of 63.3% in diagnosing CPPV. Chou et al. [12] examined the US values in the preoperative CPPV detection, wherein 179 patients underwent a US examination and contralateral side surgical exploration. They reported a sensitivity of 92.3%, a specificity of 93.7%, and a diagnostic accuracy of 93.2%. Chen et al. [4] explored only the contralateral side with positive US findings and revealed that the US accuracy in

Table 5 Distribution of ultrasonographic WLIR and laparoscopic findings of the contralateral side according to age groups

	Laparoscopic findings of the contralateral side						P value	
	No CPPV			CPPV				
	Ultrasonographic WLIR of contralateral side in mm			Ultrasonographic WLIR of contralateral side in mm				
	Median	Minimum	Maximum	Median	Minimum	Maximum		
Age group	< 2 years	2.9	2.5	6.3	3	2.6	9	0.610
	2–5 years	3	1.6	4.7	3.3	3.1	20	0.101
	> 5 years	6.4	4.7	8.1	5.2	4.1	10	1

CPPV contralateral patent processus vaginalis, WLIR width of the low echoic region at the internal ring

both symptomatic and asymptomatic sides based on the width of the internal ring was 95%. Kervancioglu et al. [13] revealed that the sensitivity, specificity, and accuracy of US were 95.4%, 85.7%, and 94.9%, respectively. In contrast to our study, they included both the presenting and contralateral sides and also explored only groins with positive findings.

Meanwhile, Lawrenz et al. [17] reported a 65% diagnostic accuracy, 78% sensitivity, and 20% specificity. These figures were reached by prospectively comparing the US finding (maximum diameter of the inguinal canal) and operative findings in both groins of 23 infants presenting with a unilateral inguinal hernia. Namgoong et al. [18] reported a 20.5% sensitivity, 95.2% specificity, 75% PPV, and 63.2% NPV, with 64.5% accuracy. These figures were reached by retrospectively comparing the US (abnormal shading) and laparoscopic findings of the contralateral side of 107 infants who presented with a unilateral inguinal hernia.

These differences in sensitivity, specificity, and accuracy of US in predicting CPPV may be explained using different sonographic criteria for PPV diagnosis in these reports. Additionally, some reports explored only the contralateral side with positive US findings. Further, we found WLIR as a problematic criterion because the internal ring is funnel-shaped, and a more precise point should be considered as a guideline for the examiner.

Our study had limitations. First, our sample size is small. Second, we only measured WLIR during rest to preoperatively diagnose CPPV.

Therefore, future studies should be conducted to determine the effect of increasing intra-abdominal pressure (straining or valsalva) on the accuracy of measuring WLIR to diagnose CPPV and compare WLIR measurement to other sonographic findings, including mid-canal width, PPV as a cyst at the internal ring, widened PPV with increases in abdominal pressure, and the PPV that contains moving fluid.

Conclusion

Measuring the WLIR by the US before herniotomy was inadequate for an accurate CPPV diagnosis in our study. Therefore, more adequate, unequivocal US criteria are required for a proper CPPV diagnosis.

Abbreviations

US	Ultrasonography
CPPV	Contralateral patent processus vaginalis
WLIR	Width of the low echoic region at the internal ring
MCIH	Metachronous contralateral inguinal hernia
OIH	Oblique inguinal hernia
PPV	Positive predictive value
NPV	Negative predictive value

Acknowledgements

Not applicable.

Authors' contributions

AA collected, analyzed, and interpreted the patient data and was a contributor to writing the manuscript. HS performed the ultrasonography. SK, ME, and AW wrote and revised the manuscript. All authors read and approved the final manuscript.

Funding

None.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Approval was obtained from the Research Ethics Committee of the Faculty of Medicine, Cairo University. Written informed consent was obtained from the parents.

Consent for publication

Written consent to publish had been obtained from the parents.

Competing interests

The authors declare that they have no competing interests.

Received: 25 October 2023 Accepted: 23 November 2023

Published online: 08 May 2024

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