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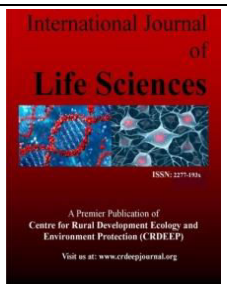

Full Length Research Paper

Clinical Value of Ultrasonic Examination of the Contralateral Side of Pediatric Patients with Congenital Inguinal Hernia

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ABSTRACT

In this research, 110 infants and children (96 boys and 14 girls) with clinically diagnosed unilateral inguinal hernia, with ages ranging from 1 month to 11 years, were subjected to preoperative ultrasonographic examination on the contralateral asymptomatic side. The examination revealed the presence of a hernia sac (or patent processus vaginalis) in the contralateral groin in 39 cases (35.5%). Those with positive ultrasonographic findings "such as viscera or fluid in inguinal canal or widening of the internal inguinal ring", underwent surgical exploration of the contralateral side, and a true hernia sac was detected in 36 of them (92.3%). The other cases were followed up for a period ranged from 6 months to one year and a hernia appeared in the contralateral side in 2 boys of them. The research demonstrated the importance of ultrasonic examination of the contralateral side in pediatric patients with a unilateral inguinal hernia especially in the first 2 years of life since it is noninvasive, cheap, available and reliable. Its accuracy in detecting the contralateral clinically inapparent inguinal hernia in pediatric patients is up to 95.5% which prevents a great percentage of children from being exposed to another surgical procedure.

Introduction

The incidence of pediatric inguinal hernia ranges from 0.8 to 4% in children and is highest in infants, especially in premature children, and decreases as children age. *(Chang et al. 2016).*Inguinal hernia repair is commonly performed on an elective basis and studies advocate early intervention to prevent incarceration *(Zamakhshary et al., 2008).*

The incidence of inguinal hernia in females is 1.9%, the ratio of boys to girls being 6:1. The site of presentation being 68.1% on the right side, 23.4% on the left and 8.5% bilateral. *(Karabulut, 2011).* Processes vaginalis is usually closed at birth, but it remains patent in 15-37% of children. The incidence is much higherin premature infants, depending on the gestational age at the time of birth. The continued patency of the processus vaginalis (PV) is the principal factor in the development of congenital hernias and hydroceles *(Davis and Cladis, 2016).*A long standing problem concerns the evaluation of the contralateral side of the groin in infants and children with unilateral inguinal hernia, since clinically inapparent inguinal hernia could be found on the opposite side in many of them *(Moss and Am, 1991).*Therefor some surgeons routinely perform bilateral inguinal exploratory surgery regardless of clinical findings, while others prefer to operate only on the side that clinically manifests a hernia *(Chou et al. 1996).*Several methods have been advocated to minimize the frequency of negative exploration of the asymptomatic contralateral side, such as herniography, pneumoperitoneum, intra-operative laparoscopy, and recently ultrasonography *(Hashish and Mashaly, 2006).*

Ultrasonography (US) is so widely available, noninvasive, rapid, reliable, and convenient technique for inguinal hernias detection in infants and children. It also decrease the time of diagnosis, provide prognostic information, and used to perform therapeutic intervention. It can provide up to 100% accuracy rate for preoperative diagnosis of direct inguinal hernia, which could be misdiagnosed by clinical examination *(Karen and John, 2015).*Therefore, in our research, we are demonstrating the width of the internal inguinal ring by US to diagnose the contralateral patent processus vaginalis (CPPV) in children. Our attempt is to evaluate the importance of ultrasonic diagnosis of the CPPV in children by measuring the internal inguinal ring. Clinical results led us to conclude that the

internal inguinal ring width demonstrated by US is useful in the evaluation of the contralateral groin in children with unilateral inguinal hernia.

Patients and Methods

A randomly chosen group of 110 children and infants (96 boys and 14 girls), varying in age from 1 month to 11 years, with clinically diagnosed unilateral inguinal hernia were studied to detect the presence of a PPV on the contralateral side, during the period from September 2017 to August 2018, in Ahmed Maher Teaching Hospital, Cairo, Egypt. All patients were examined twice by senior staff at outpatient clinic.

All patients were divided into three age groups. Group I includes children less than one year of age, group II includes children from 1-5 years (preschool age) and group III includes children from 5-11 years. Patients were subjected to preoperative ultrasonographic examination on both the symptomatic groin, and the asymptomatic opposite side. Cases with only positive ultrasonographic findings, such as viscera or fluid in the inguinal canal, or widening of the internal inguinal ring more than 4.0 mm, on one side, underwent unilateral herniotomy. Children with positive sonographic findings on both sides underwent bilateral surgical exploration, while those with negative sonographic findings of the asymptomatic groin were followed up for the occurrence of metachronous inguinal hernia.

The sonographic examination was performed in the radiology department outpatient sonography room,one to two days prior to surgery, by the same experienced senior pediatric radiologist. Sonography was performed with LOGIQ™ P7 computed sonography machine with a superficial multi-frequency linear transducer with ultra-high frequency detail.

The children were not sedated since we needed to examine them both at rest and during straining. The ultrasonic examination was performed in the sagittal plane with the patient lying down in the supine position with the probe gently placed on the groin in order not to press on the internal inguinal ring.

After the entire inguinal canal was visualized from the external to the internal rings, the width of the internal inguinal ring was measuredwhile the patient was both at rest and during straining. In this study the width of the internal inguinal ring more than 4.0 mm was considered an occult hernia (PPV).

Before the ultrasonographic examination, the clinical diagnosis was unknown to the radiologist.All patients with positive ultrasonic findings of the asymptomatic groin subsequently underwent surgical exploration after obtaining parental consent. Surgical exploration was considered to be positive if a sac more than 2.0cm in length was found below the internal inguinal ring with no traction to the cord structures, or actual communication with the peritoneal cavity was present and proved by passage of peritoneal fluid or by probing.The average time for contralateral exploration was 10-15 minutes. No intraoperative or postoperative complications were encountered.

All patients started oral feeding 2-3 hours after recovery, and were discharged on the same day of operation as day cases except for one case was transferred to pediatric ward for a wheezy chest.Patients who underwent unilateral herniotomy were followed up in the outpatient clinic, for the occurrence of metachronous contralateral inguinal hernia (MCIH), every one month thereafter.

Results

There were 96 boys, and 14 girls with male to female ratio of 6.8:1 in favor of males. Their ages ranged from 1 month to 11 years. They were divided into three age groups as follows:

- *Group I:* less than one year of age.
- *Group II:* from 1-5 years (preschool age).
- *Group III:* from 5-11 years.

The groups' distribution according to age and gender is shown in table 1.

Table (1): Age and sex distribution of the patients.

Age group	Number of patients			Incidence
	Males	Females	Total	
Group I (< 1 Year)	34	7	41	37.3%
Group II (1-5 years)	30	4	34	30.9%
Group III (5-11 years)	32	3	35	31.8%
	96	14	110	100%

There were 62 (56.4%) patients presenting with right inguinal hernia and 48 (43.6%) presenting with left inguinal hernia. The distribution of patients according to side and sex is shown in table 2.

Table (2): Distribution of study groups patients according to sex and side of presenting hernia.

Sex	Number of patients	Right hernia	Left hernia
Males	96	53	43
Females	14	9	5
Total	110	62	48

The distribution of the studied patients according to age, sex, and side of presenting hernia could be summarized in the following figures: (Fig. 1 & Fig. 2)

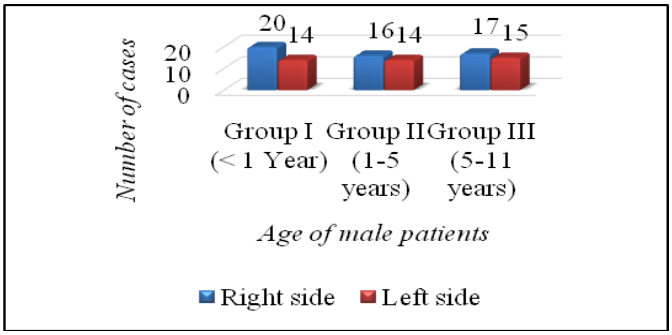

Fig. (1): Age and side of the presenting hernia distribution of the studied males group.

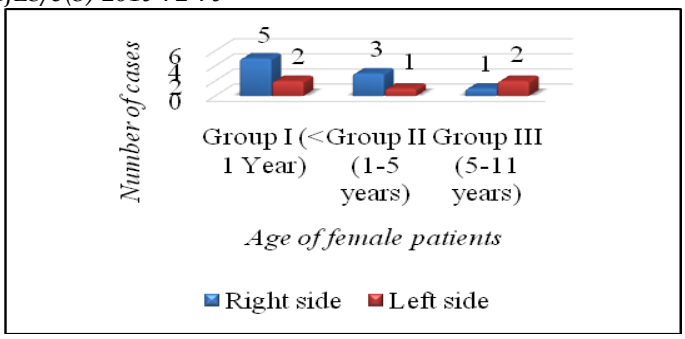

Fig. (2): Age and side of the presenting hernia distribution of the studied females group.

All groins are further subdivided into symptomatic and asymptomatic groups. All patients were examined ultrasonographically on both sides and the ultrasonic findings of the symptomatic groins, were found to have a hernia sac on examination, are summarized (Table 3) and represented (fig. 3).

Table (3): US findings of the symptomatic side group (110 groins).

Ultrasonic findings	No.	%	Right side	Left side
Viscera	14	12.7 %	8	6
Fluid	29	26.4 %	13	16
Widening of the internal ring >4 mm	67	60.9 %	41	26

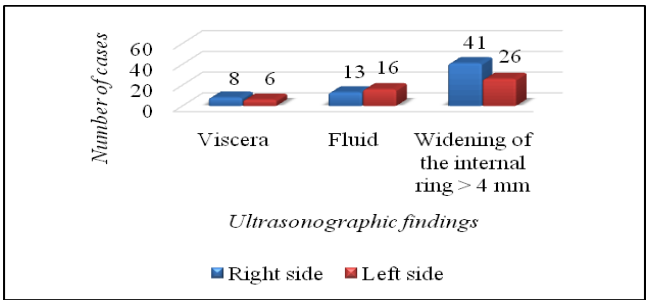

Fig. (3): US findings of the symptomatic side group (110 groins).

Among the 110 asymptomatic contralateral groins, there were positive ultrasonic findings in 39 groins (35.5%). The ultrasonic findings of the asymptomatic contralateral groins are summarized (Table 4) and represented (fig. 4).

Table (4): US findings of the asymptomatic side group (110 groins).

Ultrasonic findings	No.	%	Opposite side in patients with RH	Opposite side in patients with LH
Viscera	2	1.8 %	2	0
Fluid	7	6.4 %	3	4
Widening of the internal ring >4 mm	30	27.3 %	16	14
Total positive findings	39	35.5 %	21	18
Total negative findings	71	64.5 %	41	30

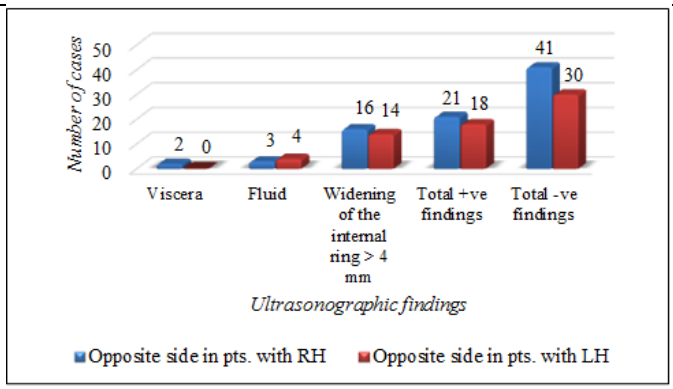

Fig. (4): US findings in the asymptomatic side group (110 groins).

The positive ultrasonic findings in the contralateral asymptomatic groins in males were found in 33 patients (34.4%), whereas those in females were found in 6 patients (42.9%). The results of ultrasonic examination of the asymptomatic opposite groins related to the 3 age groups (I, II & III) are summarized (table 5).

Table (5): Results of US of the asymptomatic side related to age groups.

Age group US results	I < 1 y	%	II 1-5 ys	%	III 5-11 ys	%
+ve findings	19	46.3%	12	35.3%	8	22.9%
-ve findings	22	53.7%	22	64.7%	27	77.1%
Total Number	41	100%	34	100%	35	100%

According to the side of the groin examined ultrasonographically, the results were as follows:

Out of 62 patients with right hernia, the contralateral left groin was positive in 21 cases, and out of 48 patients presenting with left hernia, the contralateral right groin was ultrasonographically positive in 18 cases. The distribution of the positive results of the preoperative ultrasonic examination in relation to sex and side of the groin in the asymptomatic contralateral groins are summarized (table 6) and represented (figs. 5, 6 &7).

Table (6): US findings in asymptomatic groins according to sex and side of presentation.

Item Gender	Total	Patients with RH M	 F	 Total	Patients with LH M	 F	 Total
No. of cases	110	53	9	62	43	5	48
No. of +ve US findings in the contralateral groin	39	17	4	21	16	2	18
Incidence	35.5%	32.7%	44.4%	33.9%	37.2%	40%	37.5%

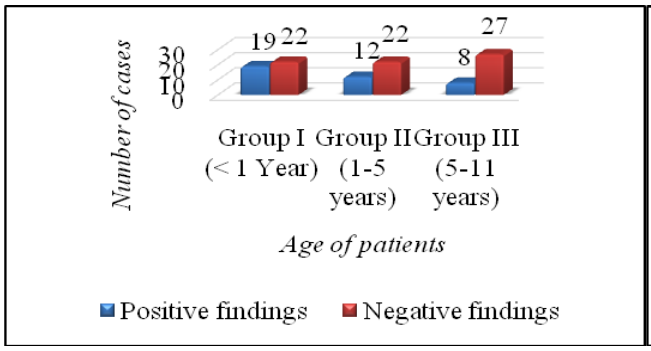

Fig. (5): US findings in the in asymptomatic contralateral groins in relation to age.

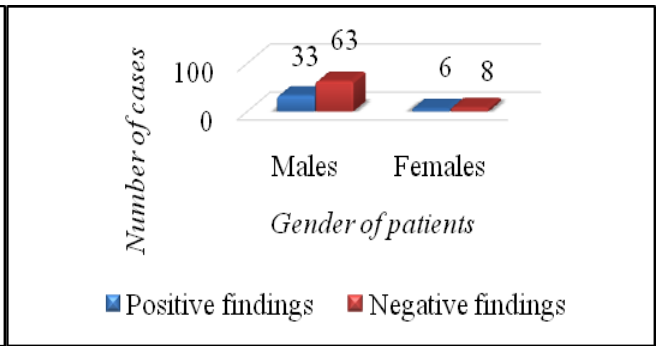

Fig. (6): US findings in the in asymptomatic contralateral groins in relation to sex.

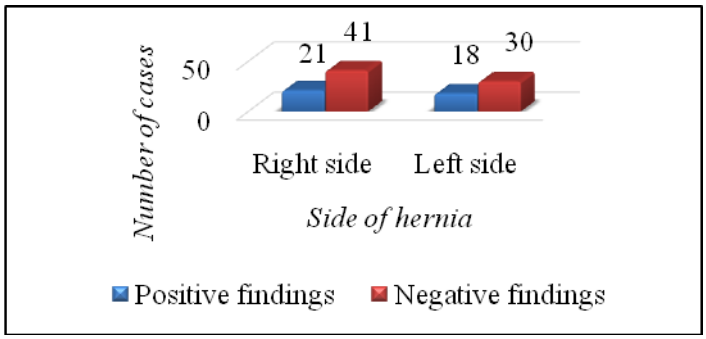

Fig. (7): US findings the in asymptomatic contralateral groins in relation to the side of presenting hernia.

There were no complications or contraindications to the procedure. It was very safe, non-invasive, and easy to perform and to interpret. This procedure needs experience and training and must be done by an experienced senior radiologist who is acquainted with the anatomy of the inguinal region. The innermost layer of the abdominal wall appeared as a high echoic line which was a reflection of the peritoneum, and the internal inguinal ring could be seen as a low echoic space because the spermatic cord and hernia sac anatomically occupied the internal ring instead of the peritoneum in boys. The sonographic findings of the internal inguinal ring in girls were the same as boys. Upon surgical exploration, all the symptomatic groins (110 cases) proved to have a hernia sac which means that US could detect the presence of a hernia sac in this group with accuracy of 100%.

Surgical exploration of the contralateral side has been done for 39 patients, who had positive findings on ultrasonographic examination. A hernia sac or a PPV, 2.0 cm or more long was found in the contralateral asymptomatic groin in 36 of them (92.3%). The distribution of the results of operative exploration of the contralateral side in relation to age, is summarized (table 7) and represented (fig. 8).

Table (7): The operative findings in the asymptomatic group, proved previously by US to have positive findings, related to age.

Age group	Group I (< 1 Year)		Group II (1-5 years)		Group III (5-11 years)	
Operative findings	**No.**	**%**	**No.**	**%**	**No.**	**%**
+ve findings	18	94.7 %	10	83.3 %	8	100 %
-ve findings	1	5.3 %	2	16.7 %	0	0 %

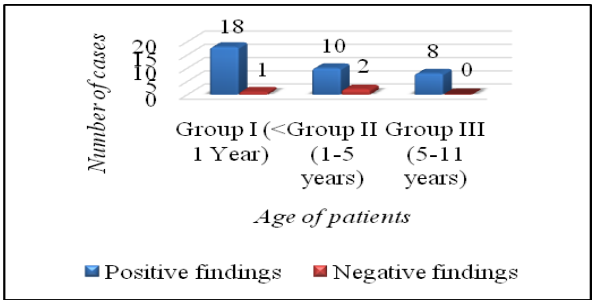

Fig. (8): The distribution or the results of operative exploration in the contralateral side, proved previously by US to have positive findings, in relation to age (39 cases).

Surgical exploration proved to be negative on the contralateral groin in 3 patients whose ultrasonic findings were positive. No sac of any length could be detected in two of them, a boy aged 5 Months and 20 days, and a girl aged 2 years. A sac of less than 1 cm long was detected in a 1 year and 4 months aged boy which was regarded as negative finding (3 false positive results of US 2.7%). The comparison between the US findings and surgical exploration in relation to age and sex is summarized (table 8) and represented (fig. 9 & fig. 10).

Table (8): Comparison between the US and surgical exploration findings in relation to age and sex in the asymptomatic group.

Age group / Findings	I	II	III	Total males	Total females
+ve US findings	19	12	8	33	6
+ve surgical findings	18	10	8	31	5

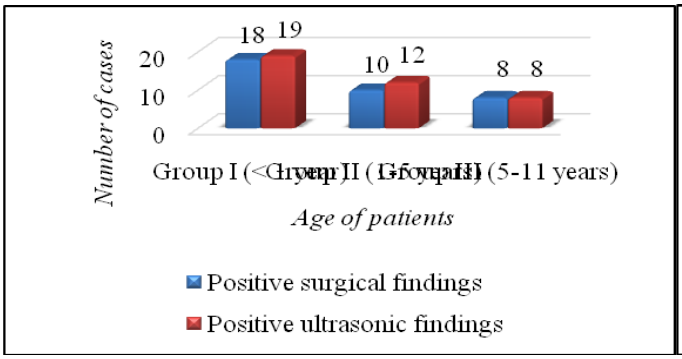

Fig. (10): Comparison between US findings and surgical exploration findings in relation to age group.

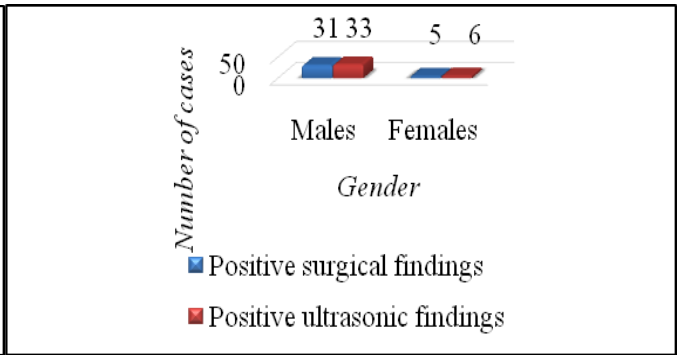

Fig. (9): Comparison between US and surgical exploration findings in relation to gender.

The results of ultrasonic examination and surgical exploration in the contralateral side in relation to the side of presenting hernia are summarized (table 9) and represented (fig. 11).

Table (9): Comparison between the US and surgical findings in the contralateral side according to side of presenting hernia.

	Patients with RH	Patients with LH	Total number
Total cases number	62	48	110
+ve US findings on the contralateral side	21	18	39
+ve surgical findings on the contralateral side	19	17	36

The patients whose ultrasonic results were negative, no operation have been done to them, and they were followed up for a period ranged from 6 months to one year. Two boys of total 71 cases whose US findings were negative, returned back with a MCIH, 6 months and 10 months postoperatively (2 false negative results of US 2.8%). Using the open exploration and the development of a metachronous hernia as live gold standard for the evaluation of the preoperative US examination of the contralateral side in pediatric patients with unilateral inguinal hernia, the positive predictive value was 92.3%, the negative predictive value was 97.2%, the sensitivity was 94.7%, and specificity was 96.1%, whereas the accuracy was 95.4% in the asymptomatic contralateral groins. In the symptomatic and asymptomatic groups together the ultrasonic

examination could correctly diagnose 146 groins (110 clinical hernias and 36 true positive hernias) out of 148 (110 clinical hernias, 36 true positive hernias and 2 false negative hernias) with accuracy of 98.6%.

The evaluation of the US examination of the contralateral side according to surgical findings and follow up is summarized (tables 10& 11).

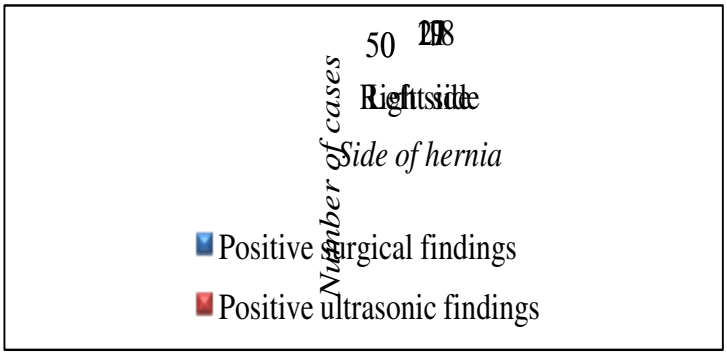

Fig. (11): Comparison between the US and surgical findings in the contralateral side according to side of presenting hernia.

Table (10): Evaluation of US findings according to surgical findings and follow up of contralateral side.

	No.	True +ve	False +ve	True -ve	False -ve
Males	96	31	2	65	2
Females	14	5	1	9	0
Total	110	36	3	74	2

Table (11): Evaluation of the preoperative US examination of the contralateral side in pediatric patients with unilateral inguinal hernia.

	Males	Females	Overall value
Positive predictive value %	93.9%	83.3%	92.3%
Negative predictive value %	97%	100%	97.3%
Sensitivity %	93.9%	100%	94.7%
Specificity %	97%	90%	96.1%
Accuracy %	95.8%	92.8%	95.4%
Prevalence %	34.4%	35.7%	34.5%

Figure (12) shows an ultrasonic image of the right contralateral groin in a 2 months old boy with left inguinal hernia. The measurement of the internal inguinal ring is 3.0 mm, which proved to be a normal canal without PPV or hernia sac.

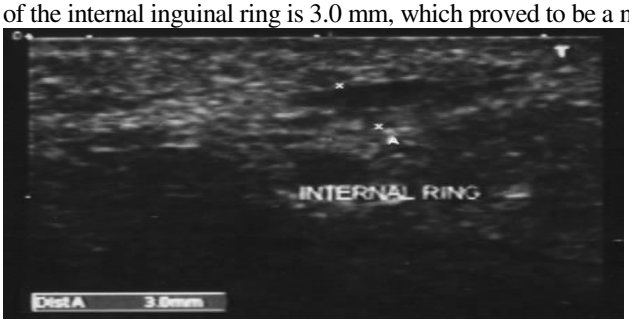

Fig. (13): Normal contralateral inguinal canal (Right) in a 2 months old boy presented with left inguinal hernia. The width of the internal inguinal ring is 3.0 mm.

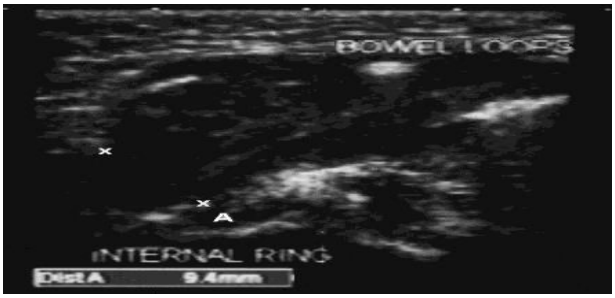

Fig. (12): Left inguinal hernia that has bowel loops is the inguinal canal in a 2.5 years old boy. The width of the internal inguinal ring is 9.4 mm.

Figure (13) shows left inguinal hernia in the symptomatic side of a 2.5 months old boy. The canal is greatly widened (9.4 mm) with bowel loops could be seen inside the canal. Figure (14) shows the left contralateral inguinal canal in a 1.5 years old boy presenting with right inguinal hernia, the width of the internal inguinal ring at rest was 4.4 mm. Figure (15) shows the left contralateral inguinal canal of the same patient in figure (14). The width of the internal inguinal ring was 5.4 mm after straining. This patient proved to have a hernia sac on the left contralateral side on surgical exploration.

Discussion

Physical examination does have limitations, particularly in attempting to determine if the contralateral side should be operated on or not. US is so widely available, noninvasive, and painless technique that provided us useful clinical information for detection of a CPPV. The median age in our study group was 2 years (range 1 month to 11 years). Most of the hernias in this series occurred in the younger patients; thus, the incidence of inguinal hernia was more important in the youngest group (age < 2 years).This coincides with the fact reported by ***Pan et al. 2013,*** that the incidence of inguinal hernia is highest during the first year of life.

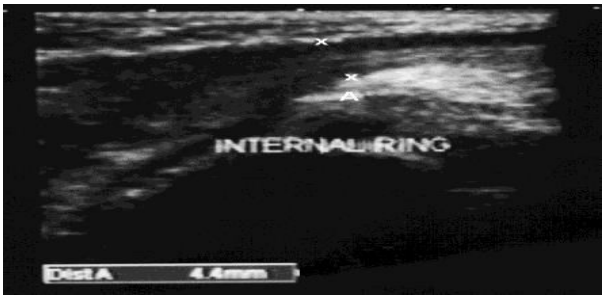

Fig. (14): Left contralateral inguinal canal with the width of internal inguinal ring is 4.4 mm at rest.

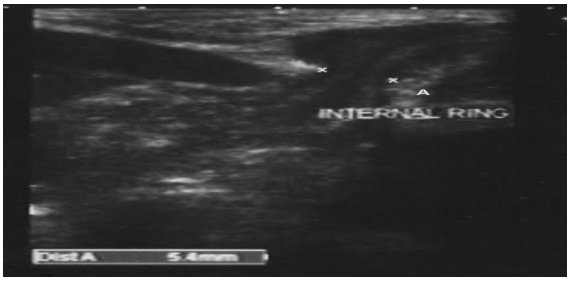

Fig. (15): The same patient in (fig. 36), left contralateral inguinal canal with a width of internal inguinal ring of 5.4 mm after straining (proved

The male to female ratio was 6.8:1 in our study, which agrees with that quoted in the literature (5:1 to 10:1), as does the higher incidence of right-sided occurrence *(Ein et al., 2006).* Reported survey data described the eventual minor risk of inguinal hernia development in females was 19% versus 81% males *(Lee et al., 2011).* In our study, we reported an incidence of 13% in females versus 87% in males.

We have experienced no cases of incarceration or strangulation as we followed The Canadian Pediatric Surgeons Guidelines, and its recommendations for optimal timing of surgical hernia repair *(Gawad et al., 2014).* It was demonstrated that surgical management should be performed 1 week after the diagnosis. Otherwise, several studies reported that the risk of incarceration doubles after a prolonged delay *(Sulkowski et al., 2015).*The recurrence rate in our study was 0% versus 0.4%, reported by *Ksia et al. (2017).*

In our study we measured the width of the sagittal oblique diameter of the internal inguinal ring, as done by*Revzin et al. (2016).* The ultrasonographic criteria for the diagnosis of inguinal hernia in this study were, the presence of bowel loops or other intraperitoneal structure, the presence of fluid in the PPV, or the widening of the low echoic region at the level of the internal inguinal ring over 4.0 mm. These criteria coincide with those used in the works of all the previous investigators with slight differences *Kervancioglu et al. (2000).*

The ultrasonic examination of the 110 symptomatic groins in our study showed 14 (12.7%) inguinal hernias containing viscera, 29 (26.4%) inguinal hernias containing fluid, and 67 (60.9%) with widening of the internal inguinal ring over 4.0 mm. However, the work done by *Chen et al. (1998)*revealed that, 32% of the symptomatic groins showed visceral hernia, 18% with fluid hernia, and 41% with widening of the internal inguinal ring, and 7% with no hernia.

The ultrasonic findings of the asymptomatic group (110 groins) in our study revealed the presence of a hernia sac (PPV) in 39 (35.5%) of patients, and 71 (64.5%) didn't show any sign of PPV and considered to be with negative ultrasonographic findings.This coincides with the work of *(Chen et al. 1998),* on examining 203 contralateral groins of boys with unilateral inguinal hernia revealed that 32% of the groins showed positive ultrasonic findings and 68% showed negative ultrasonic findings, which are near to our study results.

Anyhow the negative predictive value was 97.2% and the ultrasonic examination of the contralateral groins in pediatric patients with unilateral inguinal hernia was both sensitive and specific. The sensitivity was 94.7% and the specificity was 96.1%.Among 148 groins that actually had hernia in our study, 146 groins were correctly diagnosed with ultrasonic examination, giving this procedure an accuracy of 98.6% in diagnosing the inapparent contralateral hernias.In other studies, the US sensitivity ranged from 92.7% to 100%; specificity ranged from 22.2% to 100%; the positive predictive value ranged from 83.3% to 100%; and the negative predictive value ranged from 40% to 100%. Sonography has overall sensitivity of 96.6 %, specificity of 84.8%, and a positive predictive value of 92.6% *(Robinson et al., 2013).*

However it should be stressed that inguinal herniotomy and the contralateral exploration should only be done by an experienced pediatric surgeon, in order to avoid injury to the vas deferens or damaging testicular blood supply leading to testicular atrophy and probable sterility.

However, several invasive methods for evaluation of the contralateral inapparent hernia have been recommended but all have drawbacks and none have been widely adopted.

The availability of a reliable, non-invasive test for the detection of a clinically inapparent inguinal hernia, and the development of such a test would then prevent unnecessary surgery, shorten the time of anesthesia and enable surgeons to concentrate on those patients who truly require bilateral inguinal herniotomy.

In addition to contralateral occult hernia detection, US can also distinguish some rare forms of groin hernias, such as direct inguinal hernia and femoral hernia *(Jamadar et al., 2006).*It is also highly recommended on examination as a routine diagnostic tool in pediatric patient with inguinal hernia *(Erez et al., 2002).*

Our data only included participants who were covered in our hospital; though, we believe that our data are reliable because the high coverage rate of population of our hospital. However, the exact number of undiagnosed and untreated patients is unknown.

Conclusion

If routine bilateral exploration is performed on all infants and children who exhibit evidence of unilateral inguinal hernia, CPPV will be found in a significant number of patients with an incidence of at least 30% of cases. Though it is not known whether all these patent structures will later develop a clinical hernia or not, however, a significant number will do, and should be taken into consideration. The policy of unilateral inguinal hernia repair without contralateral exploration is not justified, as nearly 20% of patients will return later on for

repair of a hernia on the opposite side with a second hospitalization, administration of anesthesia, and a second operation. Also the emotional trauma to the child is greater when he has to return for another operation.

US examination of the inguinal region proved to be very safe, rapid, reliable, convenient, non-invasive, and easily performed screening technique for inguinal hernia in infants and children which not only detects the inapparent hernia or PPV, but also may give more information about the content of the hernia before surgery. In addition, it is so widely available and applicable to all cases.

Our data suggest that US can, with high accuracy (95.5%), guide surgeons to those inguinal canals that require prophylactic herniotomy while steering them away from those that do not.

We recommend the use of ultrasound so as to minimize unnecessary inguinal explorations, and to decrease the unnecessary returning of patients for a contralateral hernia repair. We suggest routine bilateral herniotomy in infants and children no longer be justifiable.

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