

# Prospective comparative assessment of ultrasonography and laparoscopy for contralateral patent processus vaginalis in inguinal hernia presented in the first year of life

Sherif M. Shehata<sup>a,c</sup>, AbdelMotalieb E. Ebeid<sup>a</sup>, Osama M. Khalifa<sup>c</sup>, Fayza M. Noor<sup>d</sup> and AbdelMoneim A. Noomaan<sup>b</sup>

**Background and purpose** Contralateral inguinal exploration in children with unilateral inguinal hernia is still a controversial topic. The aim of this study was to present an evidence-based justification for contralateral inguinal exploration in our population after comparing the results of ultrasonography (US) and laparoscopy.

**Methods** Over a period of 3 years, 246 patients (207 boys and 39 girls) with unilateral inguinal hernia who were presented in the first year of life underwent an US using a 10 MHz linear transducer. Operative transinguinal contralateral laparoscopic exploration was carried out in all of them. The results were compared prospectively for the sensitivity and specificity of US and laparoscopy.

**Results** Our results showed a predominant left-side incidence in boys (50.7%) and a right-side incidence in girls (69.2%). With respect to prematurity, 24.6% of boys and 30.8% of patients with left-sided hernia were found to be premature. In all, 64.6% of patients were diagnosed in the neonatal period. We considered positive patent processus vaginalis (PPV) on US when types I–III according to the criteria of Toki and colleagues were reported. Positive PPV was confirmed by US in 30.5% of patients and by laparoscopy in 85.2%. Sonographic assessment of contralateral PPV gave a sensitivity of 91.7% and a specificity of 87.7%. Of the patients, the laparoscopic exploration yielded positive results in 35.8%. The cost

of a negative laparoscopy is 50\$ and that of a positive laparoscopy is 100\$, which on second admission costs 500\$.

**Conclusion** As in our community there is a high incidence of consanguinity, preoperative assessment of contralateral hernia should be considered in patients who are presented in the first year of life and in premature infants. In experienced hands US is a highly sensitive tool for the diagnosis of contralateral hernia. Laparoscopic exploration is safe, rapid, and a proven method for diagnosis, even in infants. We recommend laparoscopic exploration for all patients who are presented in the first year of life in order to avoid second admission, which can lower costs significantly. *Ann Pediatr Surg* 9:6–10 © 2013 Annals of Pediatric Surgery.

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Departments of <sup>a</sup>Pediatric Surgery, <sup>b</sup>Diagnostic Imaging, Tanta University Hospital, Tanta, Egypt, Departments of <sup>c</sup>Pediatric Surgery and <sup>d</sup>Diagnostic Imaging, Royal Commission Medical Center (RCMC), Yanbu, Kingdom of Saudi Arabia

Correspondence to AbdelMotalieb E. Ebeid, MD, Department of Pediatric Surgery, Faculty of Medicine, Tanta University, Elgish St. 31111 Tanta, Egypt  
Tel: +20 100 797 5755; fax: +002 040 221 8886;  
e-mails: ameffat@hotmail.com, ameffat@yahoo.com

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## Introduction

Contralateral exploration of the groin has been a common practice among pediatric surgeons for nearly 50 years, based on the high incidence of patent processus vaginalis (PPV) on the contralateral side with the potential for subsequent development of hernia [1]. However, the actual incidence of hernia among PPV patients is not definite. The patency rate of processus vaginalis is highest in infants, but there are few data on the subsequent risk of developing contralateral hernia in them [2]. The incidence of contralateral PPV (CPPV) is higher among infants and premature boys [3]. Despite this fact, contralateral inguinal exploration is a controversial subject in both infants and older children [4,5]. Many methods have been used for the diagnosis of CPPV in unilateral cases of inguinal hernia to benefit from nonroutine operative exploration as it avoids unnecessary open exploration in 66% of infants and children undergoing inguinal hernia repair [6]. Further, it also avoids exposure to general anesthesia for the second time, which is found

favorable by parents as well [7]. Ultrasonography (US) is one of the noninvasive techniques used to diagnose CPPV preoperatively using a 7.5 MHz superficial linear transducer either by detecting as a hydrocele owing to the inflow of physiologic ascites into a processus vaginalis on straining or classified according to Toki and colleagues criteria [8,9]. Management of CPPV in a child with an inguinal hernia has been debated upon by surgeons for more than 50 years [7]. With the advent of laparoscopy, many techniques have been utilized through both conventional and tangential laparoscopic approaches [10–12]. Tangential laparoscopy is especially important in infants below 1 year of age [13]. Evidence-based guidelines should be followed, even in the case of small or premature infants, which outline the standard of care to be adopted in a common pediatric surgical practice [14]. Middle Eastern countries and many developing countries exhibit a high incidence of consanguinity. No studies were available from communities in which high consanguinity was prevalent.

The aim of this study was to present an evidence-based justification for CPPV exploration in our population after comparing the results of US and laparoscopy in a prospective manner and to prospectively evaluate laparoscopic exploration for CPPV in a cost-effective manner.

### Patients and methods

All patients with unilateral inguinal hernia who were presented in the first year of life over a period of 3 years (from January 2007 to December 2009) were included in the study. They comprised children presented at the Department of Pediatric Surgery, Royal Commission Medical Center, Yanbu, Kingdom of Saudi Arabia, from January 2007 to 30 June 2008, and at the Department of Pediatric Surgery, Tanta University Hospital, Egypt, from January 2008 to December 2009. The ethical research committee of both institutions approved the study design. All patients underwent preoperative US using a 10MHz linear transducer. Preoperative sonographic results of patients with CPPV were classified according to the criteria of Toki *et al.* [9], in which the findings, along with increases and decreases in intra-abdominal pressure, were categorized into six types as follows: type I – an intra-abdominal organ was observed in the inguinal canal; type II – the PPV was seen as a cyst at the internal ring of the inguinal canal; type III – the PPV was widened with increases in abdominal pressure (the length of the PPV was longer than 20 mm); type IV – the PPV contains moving fluid without PPV widening; type V – the PPV was widened with increases in abdominal pressure (the length is shorter than 20 mm); and type VI – other findings. Types I, II, and III were regarded as positive potential candidates for inguinal hernia. An operative tangential transinguinal contralateral laparoscopic exploration was performed in all patients. A 5 mm laparoscope was inserted and a 30° scope was passed tangentially after CO<sub>2</sub> insufflation. Pressure ranging between 8 and 10 mmHg was found to be sufficient for the procedure with a flow rate of 0.5–1 l/min. The CPPV was inspected and evaluated. If the CPPV measured more than 1 cm in length and 5 mm in diameter on laparoscopic exploration, it was considered positive and was subjected to open herniotomy during the same session. If the diameter was less than 5 mm or the length of the CPPV was less than 1 cm, no intervention was performed as it was considered negative [3,7,11]. Positive results were compared with respect to sensitivity and specificity of both US and laparoscopic findings.

### Results

A total 246 patients (207 boys and 39 girls) who were presented with unilateral inguinal hernia for the first time in the first year of life over a period of 3 years were included in the study. Left-sided presentation was reported to be predominant in boys (50.7%), whereas the right side predominated among girls (69.2%). With respect to prematurity, 24.6% of boys and 30.8% of patients with left-sided hernia were found to be premature. Among the premature boys, the ratio of left to right side incidence was reported as 2.65 : 1. A total of 159 patients (64.6%)

were diagnosed during the neonatal period. Nine patients were presented to the emergency department with irreducibility, which was reduced manually and electively operated during the same admission.

Preoperative US revealed 75 patients with positive findings according to Toki's classification. We considered positive PPV on US when types I–III, according to Toki and colleagues, were reported. Of the 75 positive patients, 15 were classified as type I, 33 as type II, and 27 as type III; 171 patients were considered negative. Figure 1 shows representations of the different types of Toki's classification as seen among our patients.

Sonographic assessment of CPPV gave a sensitivity of 91.7% and a specificity of 87.7%. We obtained a false-negative rate of 24.1% with a positive predictive value of 75.9% and a false-positive rate of 3.8% with a negative predictive value of 96.2%. All patients underwent unilateral open herniotomy on an elective basis. Median operative age for all patients was 45 weeks, whereas that for the neonatally diagnosed patients was 13.3 weeks for full term and 21 weeks for premature babies; 54.3% of patients below 1 year of age were operated upon. Figure 2 shows the laparoscopic technique and the results of the laparoscopic exploration.

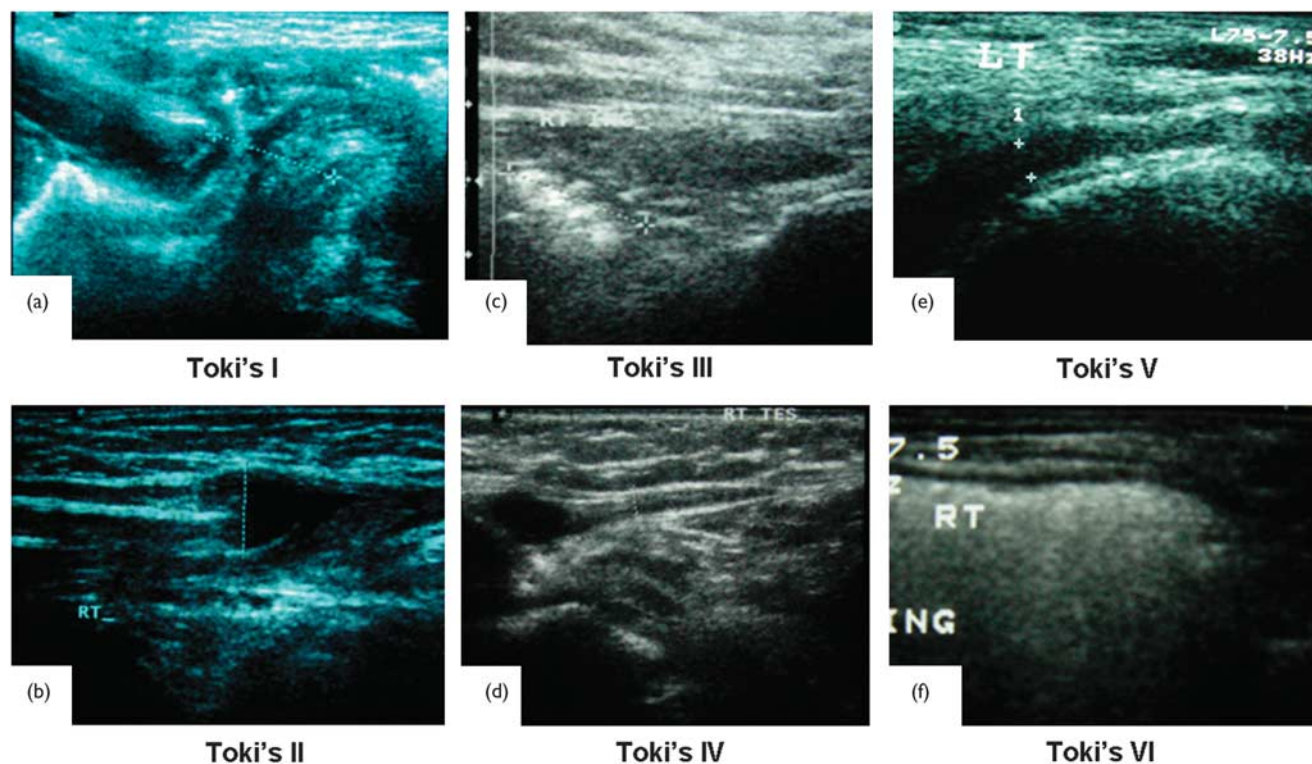
Of all the laparoscopic explorations performed in the groups, 35.8% were positive. US confirmed PPV in 30.5% of patients, whereas laparoscopy confirmed it in 85.2%. Laparoscopic exploration had significantly higher sensitivity compared with US (100 and 91.7%, respectively). Patients with a positive result on laparoscopic exploration were managed by classic open herniotomy of the contralateral side during the same session. The added median cost of negative laparoscopy was 50\$, whereas positive laparoscopy cost 100\$, which on second admission had a median cost of 500\$ per patient. After calculating the costs of both negative and positive laparoscopic exploration on avoiding a second admission, we could save 27 300\$ during our study period, which was beneficial in terms of hospital resources.

### Discussion

The evaluation and management of CPPV in children presenting with a unilateral inguinal hernia has been a subject of debate for over 60 years [15]. US is a noninvasive and accurate method for evaluating the presence of a CPPV [8]. Although the efficacy of US against that of laparoscopy in the diagnosis of CPPV has been evaluated earlier, the age group tested in this study in the developing community has not been considered before. Intraoperative laparoscopy using a no-puncture technique through the opened hernia sac is useful for inspecting CPPV [10].

By combining all the published studies and using the technique of meta-analysis, intraoperative laparoscopy can be shown to be effective in diagnosing CPPV in children undergoing unilateral inguinal herniorrhaphy [16]. Risk for metachronous manifestation of contralateral inguinal hernia in patients with unilateral inguinal hernia was shown to be significantly higher in boys with

Fig. 1



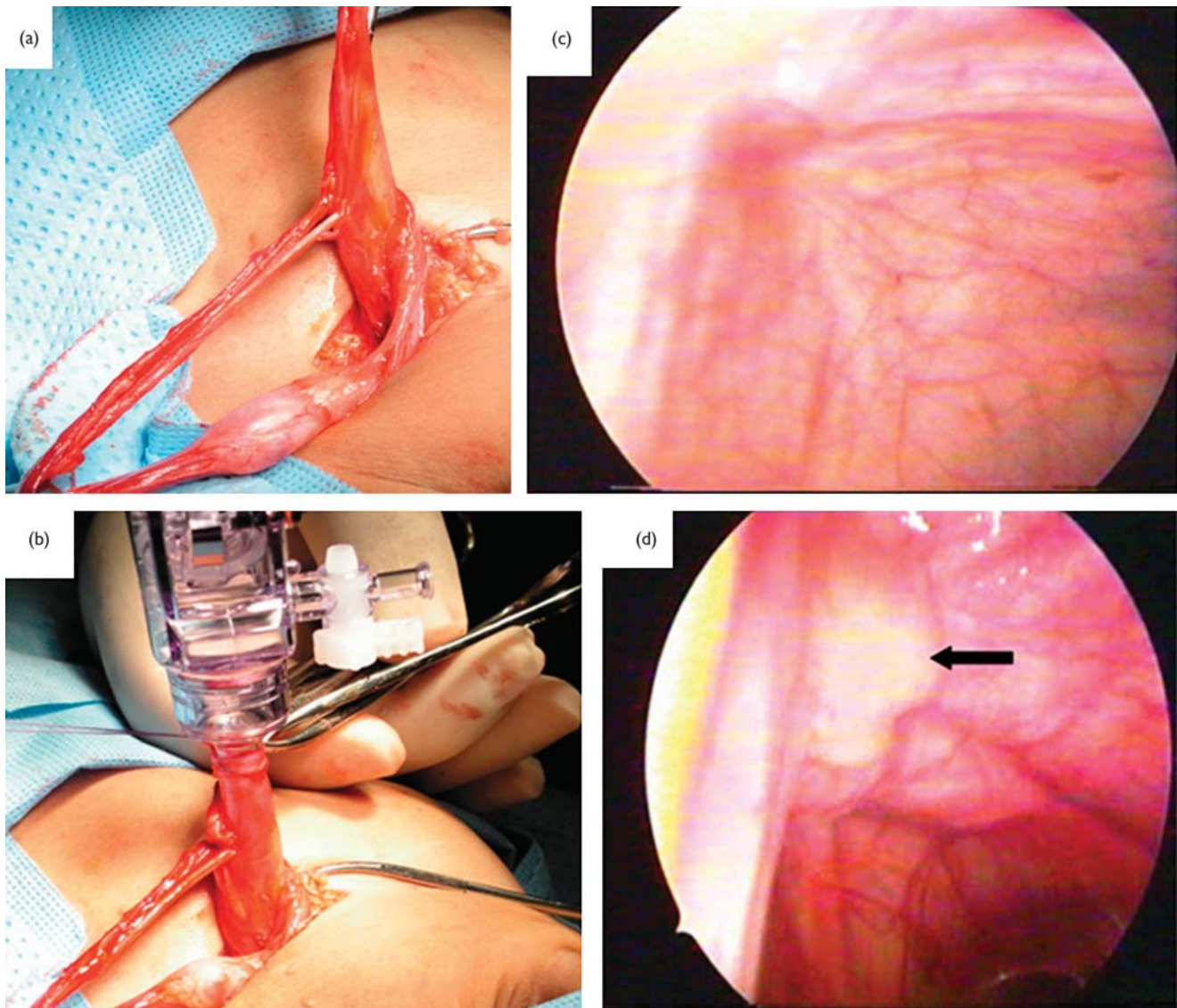
A panel of sonographic photographs representing preoperative US evaluation for contralateral PPV in different infants showing (a) preoperative sonographic photograph of Toki's type I PPV, (b) preoperative sonographic photograph of Toki's type II PPV, (c) preoperative sonographic photograph of Toki's type III PPV, (d) preoperative sonographic photograph of Toki's type IV PPV, (e) preoperative sonographic photograph of Toki's type V PPV, and (f) preoperative sonographic photograph of Toki's type VI PPV. Types I, II, and III were considered positive, whereas types IV, V, and VI were considered negative. PPV, patent processus vaginalis; US, ultrasonography.

left-sided hernia, in premature children, and in patients with a positive family history [5,6,17]. Left-sided presentation was reported to be 50.7% among boys and 30.8% among girls. This was in accordance with our findings of common left-sided presentation in premature boys, which we reported as 2.65 : 1 when compared with right-sided presentation. Patients with left-sided presentation of hernia have a statistically significantly higher incidence of metachronous inguinal hernia [14]. In our study, 24.6% of boys and 30.8% of patients with left-sided hernia were premature. We had 207 boys among the 246 patients in our study with unilateral inguinal hernia for the first time in the first year of life. Schier *et al.* [18] reported an incidence of 23% for CPPV in patients with left-sided hernia and 22% among those with hernia on the right side; Eller Miranda and Duarte Lanna [19] reported a significantly higher incidence of contralateral hernia in patients with left-sided hernia, similar to our results. The overall median operative age was 45 weeks in our study, which was lower compared with that of others [18,20]. Hata *et al.* [8] reported that US with a 7.5 MHz linear transducer is a useful noninvasive tool for evaluating CPPV and had a specificity of 94.9%. In our study US had a sensitivity of 91.7%, which was lower than the sensitivity of 98.5% reported by Toki *et al.* [9], who used a 10 MHz linear transducer. The lower sensitivity for US in our study is not significant and could be attributed to the lower median age of our patients as compared with

similar studies [4,8,9,21] as US has been proven difficult to perform in very young infants.

We experienced 100% success in laparoscopic exploration even in thin sacs using the purse string suture around the cannula for insufflation when compared with a failure rate of 4.4% in passing the laparoscopic port in the study by Valusek *et al.* [22]. In all, 35.8% of all patients underwent a positive laparoscopic exploration. This supported the findings that laparoscopy can be used to reliably evaluate the contralateral inguinal region and is the best method to evaluate the presence of a CPPV as reported by Valusek *et al.* [22] and Tamaddon *et al.* [23] as 39 and 38%, respectively. Tamaddon *et al.* [23] reported that transinguinal laparoscopic evaluation using a 120° endoscope provided superior visualization and identification of CPPVs. However, we did not encounter problems on using a 30° endoscope in our study. The transinguinal tangential laparoscopic exploration proved to be effective in the diagnosis of CPPV without the need for a separate abdominal wall puncture and reduced the instances of missed PPV [13,22–24]. In our study, patent PPV was US confirmed in 30.5% of patients by US and in 85.2% by laparoscopy. Laparoscopy had a sensitivity of 100%. In a study conducted by Miltenburg *et al.* [16] on 964 patients, the sensitivity of laparoscopy was 99.4% (95% confidence interval 97.87–99.91). These findings were in agreement with former reports [7,15,22], thus denoting

Fig. 2



A panel of operative photographs showing (a) the operative view of a 9-month-old infant in which the right hernia sac is identified before introducing the laparoscope; (b) an operative view of the same case showed passing of the laparoscopic trocar in a tangential transinguinal laparoscopy through the fundus of the hernia sac; (c) a laparoscopic view of the same case showed closed contralateral PPV on laparoscopy; (d) a laparoscopic view of another case showing open contralateral PPV with indentation and evident fundus of hernia (black arrow). PPV, patent processus vaginalis.

the superiority of laparoscopy in the diagnosis of CPPV. Niyogi *et al.* [25] reported the statistical advantages of laparoscopy in the diagnosis of CPPV. The technique of increasing and decreasing intra-abdominal pressure during both US and laparoscopy proved very valuable and we used this technique in all patients in our study. CPPV was predominantly prevalent among patients with left-sided hernia and in premature boys, as described by many studies [6,7,13,14]. In the current study, laparoscopic exploration showed significantly higher sensitivity in diagnosing CPPV when compared with US. The predicted incidence of contralateral hernia in the study by Watanabe *et al.* [26] was 11.2%. We reported a higher incidence of 35.8% for CPPV in our study. This could be attributed to the high incidence of consanguinity among families in our area and the Middle East. For this reason, laparoscopy can be effectively used to evaluate the

contralateral inguinal region and is the best method to evaluate a CPPV [22]. The laparoscopic exploration for CPPV is cost effective in terms of both cost to the patient and hospital resources as the positive exploration costs 100\$. However, the minimum cost on second admission is 500\$. Cost analysis comparing the time taken to perform laparoscopic exploration for CPPV with the cost saved by preventing future surgery for a contralateral inguinal hernia repair was calculated on the basis of Medicare reimbursement [27]. We found that we had saved 27 300\$ during our study period, which was in agreement with the results of Lee *et al.* [27] who calculated the total cost for a second operation to repair the contralateral inguinal hernia as 20 440\$ per patient in the USA. The relatively high incidences of both CPPV and contralateral metachronous hernia development in children justify the use of laparoscopic evaluation as a routine [15]. Contralateral

exploration should therefore be reserved for high-risk patients in whom administration of anesthesia and surgery for the second time have to be avoided [17]. Therefore, diagnostic intraoperative transinguinal laparoscopic evaluation of CPPV during pediatric inguinal hernia repair is a simple, accurate, fast, and effective method to assess the CPPV, improving decision making, reducing the number of negative explorations, and sparing the surgeon the embarrassment associated with the appearance of a metachronous hernia at a later date [24]. Transinguinal laparoscopy offers a safe and effective means of evaluating the contralateral inguinal ring during ipsilateral hernia repair [27].

## Conclusion

Contralateral exploration should be reserved for high-risk patients in whom administration of anesthesia and surgery for the second time have to be avoided [17]. In our community, preoperative assessment of contralateral hernia is justified and should be considered. It can be learned easily and should be a part of every pediatric surgeon's practice. Laparoscopic contralateral groin exploration at the time of unilateral inguinal hernia repair is cost effective. With a 35.8% incidence of positive PPV patients, laparoscopic exploration is safe, rapid, and a sure method for diagnosis even in infants. We recommend the laparoscopic exploration of PPV in all patients who are presented in the first year of life so as to avoid a second admission, leading to a significant lowering of costs and avoiding a second exposure to general anesthesia, which may result in complications.

## Acknowledgements

### Conflicts of interest

There are no conflicts of interest.

## References

- Lotan G, Efrati Y, Stoloro S, Klin B. Transinguinal laparoscopic examination: an end to the controversy on repair of inguinal hernia in children. *Isr Med Assoc J* 2004; **6**:339–341.
- Shabbir J, Moore A, O'Sullivan JB, Delaney PV, Drumm J, Flood H, Grace PA. Contralateral groin exploration is not justified in infants with a unilateral inguinal hernia. *Ir J Med Sci* 2003; **172**:18–19.
- Schier F, Danzer E, Bondartschuk M. Incidence of contralateral patent processus vaginalis in children with inguinal hernia. *J Pediatr Surg* 2001; **36**:1561–1563.
- Nassiri SJ. Contralateral exploration is not mandatory in unilateral inguinal hernia in children: a prospective 6-year study. *Pediatr Surg Int* 2002; **18** (5–6):470–471.
- Ballantyne A, Jawaheer G, Munro FD. Contralateral groin exploration is not justified in infants with a unilateral inguinal hernia. *Br J Surg* 2001; **88**:720–723.
- Geisler DP, Jegathesan S, Parmley MC, McGee JM, Nolen MG, Broughan TA. Laparoscopic exploration for the clinically undetected hernia in infancy and childhood. *Am J Surg* 2001; **182**:693–696.
- Holcomb GW III, Miller KA, Chaignaud BE, Shew SB, Ostlie DJ, Zitsman J. The parental perspective regarding the contralateral inguinal region in a child with a known unilateral inguinal hernia. *J Pediatr Surg* 2004; **39**:480–482.
- Hata S, Takahashi Y, Nakamura T, Suzuki R, Kitada M, Shimano T. Preoperative sonographic evaluation is a useful method of detecting contralateral patent processus vaginalis in pediatric patients with unilateral inguinal hernia. *J Pediatr Surg* 2004; **39**:1396–1399.
- Toki A, Watanabe Y, Sasaki K, Tani M, Ogura K, Wang Z-Q, Wei S. Ultrasonographic diagnosis for potential contralateral inguinal hernia in children. *J Pediatr Surg* 2003; **38**:224–226.
- Birk D, Formentini A, Poch B, Kunz R, Beger HG. The value of intraoperative laparoscopic examination of the contralateral inguinal ring during hernia repair in children. *J Laparoendosc Adv Surg Tech* 1998; **8**:373–379.
- Nixon RG, Pope JC IV, Adams MC, Holcomb GW III, Brock JW III. Laparoscopic variability of the internal inguinal ring: review of anatomical variation in children with and without a patent processus vaginalis. *J Urol* 2002; **167** (4 I):1818–1820.
- Owings EP, Georgeson KE. A new technique for laparoscopic exploration to find contralateral patent processus vaginalis. *Surg Endosc* 2000; **14**:114–116.
- Van Glabeke E, Khairouni A, Gall O, Le Pointe HD, Jaby O, Larroquet M, et al. Laparoscopic diagnosis of contralateral patent processus vaginalis in children under 1 year of age with unilateral inguinal hernia: comparison with herniography. *J Pediatr Surg* 1999; **34**:1213–1215.
- Manoharan S, Samarakkody U, Kulkarni M, Blakelock R, Brown S. Evidence-based change of practice in the management of unilateral inguinal hernia. *J Pediatr Surg* 2005; **40**:1163–1166.
- Mollen KP, Kane TD. Inguinal hernia: what we have learned from laparoscopic evaluation of the contralateral side. *Curr Opin Pediatr* 2007; **19**:344–348.
- Miltenburg DM, Nuchtern JG, Jaksic T, Kozinetz C, Brandt ML. Laparoscopic evaluation of the pediatric inguinal hernia – a meta-analysis. *J Pediatr Surg* 1998; **33**:874–879.
- Ikeda H, Suzuki N, Takahashi A, Kuroiwa M, Sakai M, Tsuchida Y. Risk of contralateral manifestation in children with unilateral inguinal hernia: should hernia in children be treated contralaterally? *J Pediatr Surg* 2000; **35**:1746–1748.
- Schier F, Montupet P, Esposito C. Laparoscopic inguinal herniorrhaphy in children: a three-center experience with 933 repairs. *J Pediatr Surg* 2002; **37**:395–397.
- Eller Miranda M, Duarte Lanna JCB. Videolaparoscopy of the contralateral internal inguinal ring via the hernia sac in children with unilateral inguinal hernia-initial experience in Brazil, with a meta-analysis. *Pediatr Surg Int* 2002; **18** (5–6):463–469.
- Chou TY, Chu CC, Diau GY, Wu CJ, Gueng MK. Inguinal hernia in children: US versus exploratory surgery and intraoperative contralateral laparoscopy. *Radiology* 1996; **201**:385–388.
- Kervancioglu R, Bayram MM, Ertaskin I, Ozkur A. Ultrasonographic evaluation of bilateral groins in children with unilateral inguinal hernia. *Acta Radiol* 2000; **41**:653–657.
- Valusek PA, Spilde TL, Ostlie DJ St, Peter SD, Morgan WM III, Brock JW III, Holcomb GW III. Laparoscopic evaluation for contralateral patent processus vaginalis in children with unilateral inguinal hernia. *J Laparoendosc Adv Surg Tech* 2006; **16**:650–653.
- Tamaddon H, Phillips JD, Nakayama DK. Laparoscopic evaluation of the contralateral groin in pediatric inguinal hernia patients: a comparison of 70- and 120-degree endoscopes. *J Laparoendosc Adv Surg Tech* 2005; **15**:653–660.
- Klin B, Efrati Y, Abu-Kishk I, Stoloro S, Lotan G. The contribution of intraoperative transinguinal laparoscopic examination of the contralateral side to the repair of inguinal hernias in children. *World J Pediatr* 2010; **6**:119–124.
- Niyogi A, Tahim AS, Sherwood WJ, De Caluwe D, Madden NP, Abel RM, et al. A comparative study examining open inguinal herniotomy with and without hernioscopy to laparoscopic inguinal hernia repair in a pediatric population. *Pediatr Surg Int* 2010; **26**:387–392.
- Watanabe T, Nakano M, Endo M. An investigation on the mechanism of contralateral manifestations after unilateral herniorrhaphy in children based on laparoscopic evaluation. *J Pediatr Surg* 2008; **43**:1543–1547.
- Lee SL, Sydorak RM, Lau ST. Laparoscopic contralateral groin exploration: is it cost effective? *J Pediatr Surg* 2010; **45**:793–795.