

# Laparoscopic Versus Open Inguinal Hernia Repair in Pediatric Patients: A Systematic Review

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## Abstract

**Aim:** Inguinal hernia is one of the most common surgical conditions in infants and children. However, considerable debate exists regarding the role of laparoscopic hernia repair (herniorrhaphy) (LH) and its benefits over conventional open hernia repair (herniorrhaphy) (OH). The aim of this review is to analyze the current literature to determine the outcome of LH compared with OH.

**Materials and Methods:** A literature search was performed on all studies published during the last 20 years, reporting on outcomes of OH and LH, in terms of operative time, recurrence rate and other complications, finding of rare hernias, and incidence of contralateral patency. The chi-squared or Fisher's exact test was used to analyze the results of the study.

**Results:** Fifty-three studies matched our inclusion criteria. As for operative time, in unilateral inguinal hernia repair, there was no significant difference between LH and OH ( $P = .33$ ). In contrast, in bilateral disease, LH is faster than OH ( $P = .01$ ). As for the recurrence rate, no significant difference was observed between the two techniques ( $P = .66$ ), whereas the rate of other complications was significantly higher for OH compared with LH ( $P = .001$ ). Laparoscopy has the advantage to identify and treat rare hernias (direct, femoral, "en pantalon") that are never reported in articles focused on inguinal OH. In laparoscopic series, in the case of unilateral hernia, the incidence of contralateral patency varied between 19.9% and 66%.

**Conclusions:** In this systematic review, it seems that LH is faster than OH for bilateral hernias, whereas there is no significant difference in terms of operative time for unilateral inguinal hernia repair. Recurrence rate is similar for both techniques. As for other complications such as wound infections, it is higher for OH compared with LH, especially in infants. A prospective comparative study is necessary on this topic to strongly support the results of our systematic review.

## Introduction

THE INCIDENCE OF AN INGUINAL hernia in children less than 18 years of age ranges from 0.8% to 4.4%.<sup>1</sup> Eighty-five percent of patients with an inguinal hernia present with a unilateral hernia.<sup>1</sup> The incidence of incarceration in the unrepaired hernia in infants and young children seems to vary between 6% and 18%, but it increases to approximately 30% in infancy, with a potential risk to the bowel and testicle.<sup>2</sup> Bilateral inguinal hernia is significantly more common in younger patients (present in 50% if less than 1 year, 45% if less than 2 years, and 37% if less than 5 years).<sup>3</sup> In patients undergoing a unilateral hernia repair, there is a 5%–20% chance

that a hernia will develop on the contralateral side requiring subsequent repair.<sup>3</sup>

The traditional inguinal approach is an excellent method for hernia repair in the pediatric population. However, it has the potential risk of injury of the spermatic cord and vas deferens, hematoma, wound infection, iatrogenic cryptorchidism, testicular atrophy, and recurrence of hernia.<sup>4,5</sup>

Inguinal laparoscopic hernia repair (herniorrhaphy) (LH) in children has been introduced as an alternative method to conventional open hernia repair (herniorrhaphy) (OH), described for the first time by Montupet in 1993 as noted by Schier.<sup>6</sup>

Regarding the technical point of view, there are many techniques now in practice for LH. The different repair options

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can be categorized as either intracorporeal or extracorporeal/percutaneous. With regard to intracorporeal repairs, in 1993 Montupet, as noted by Schier,<sup>6</sup> first described the technique, consisting in a purse-string suture performed on the peri-orificial peritoneum at the level of the internal ring. In 1998, Schier<sup>6</sup> introduced his technique, consisting in a “N”-shaped suture on the peri-orificial peritoneum. In 2004, Becmeur and coworkers, as noted by Ostlie and Ponsky,<sup>7</sup> described the laparoscopic division and resection of the hernia sac at the level of the internal ring with subsequent closure of the peritoneal edges. The extracorporeal techniques all involve the placement of a suture circumferentially around the internal ring and tying the knot using percutaneous techniques. Many variations of this approach have been described.<sup>7</sup>

Recently, Ostlie and Ponsky<sup>7</sup> stated that there is not sufficient evidence to support one approach over another. However, addition of the peritoneal injury intentionally created at the internal ring, as reported in their preferred technique and in Montupet’s modified technique, described by Esposito et al.,<sup>8</sup> seems to result in a more durable repair.

The proposed advantages of the laparoscopic technique are visualization of contralateral defects, diminished postoperative pain, improved cosmetic results, and more rapid return to normal function. Controversy remains, however, regarding a possible increase in length of operative time, costs, complications, indications, and contraindications. Whether LH is superior to OH continues to be debated.

This review aims to evaluate the role of LH in children and to compare LH with OH in regard to operative time, postoperative complications, recurrence rate, discovering of rare hernias, and incidence of contralateral patency.

## Materials and Methods

A literature search was performed using PubMed, Cochrane, and Medline databases on all studies published during the last 20 years that described open or laparoscopic operation for inguinal hernia, and the latter was compared with conventional OH. The following key words were used: “inguinal hernia,” “herniorrhaphy,” “hernia repair,” “children,” “laparoscopic versus open herniorrhaphy,” “laparoscopic versus open hernia repair,” “contralateral patency,” “complications,” and “recurrence.” Searches were also performed using the following as limits: clinical trials, randomized controlled trials, multicenter retrospective, prospective studies, and expert opinion. Conference abstracts were excluded because of the limited data presented in them. Publications with evidence of possible overlap were also excluded from this review.

Although no language restrictions were imposed initially, the search was limited to studies published in the English language for the full-text review and final analysis. Eligibility criteria included all available studies focused on LH and/or OH and with quantitative data on outcome parameters. The pediatric population was defined as younger than 18 years when the patient underwent LH or OH.

After relevant titles were identified, the abstracts of these studies were read to decide if the study was eligible. The full article was retrieved when the information in the title and/or abstract appeared to meet the objective of our review. The authors independently assessed selected studies and tabulated data from each article with a predefined data extraction form. Data regarding the following factors were considered:

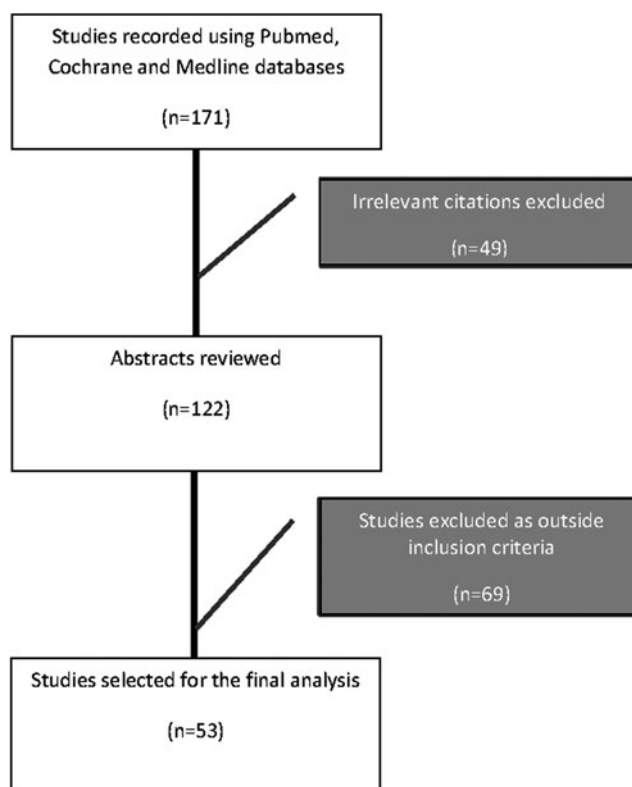


FIG. 1. Flowchart of the search process.

first author, publication date, study method, participant features, intervention characteristics, definition of complications, and outcome measures. Outcome parameters for inclusion were patients’ age, gender, affected side, operative time, time to resume full activity, duration of hospital stay, recurrence, metachronic contralateral hernia, and complications.

We recorded 171 studies, but 118 of these were excluded from our analysis using the following criteria: studies in which the outcomes of interest were not reported for one of the two techniques or it was impossible to calculate these from the published results, studies that were not focused on a pediatric population, and studies reporting modifications of the standard laparoscopic techniques (Fig. 1).

The chi-squared or Fisher’s exact test was used to evaluate the significance of differences between the two groups: LH and OH.

## Results

Fifty-three studies matched the inclusion criteria and were selected for the final analysis.<sup>1–6,9–55</sup> Of the studies analyzed, there were 39 clinical trials, 5 randomized clinical trials, and 9 multicenter studies. All studies showed a total population of 19,022 children and adolescents (age, 0–18 years) who underwent hernia repair by laparoscopic (LH) (11,591 cases, 60.9%) or open (OH) (7440 cases, 39.1%) techniques and reported operative time, postoperative recurrence and complications, conversion rate, rare hernias, and incidence of contralateral patency. Nine studies were focused only on OH, 11 were comparative studies between OH and LH, and 39

articles were focused only on LH. Seven studies were focused only on incarcerated hernias, and two studies were only about the repair of recurrent hernias. Three studies were focused only on infants ( $n = 270$ ).<sup>50-52</sup>

#### Operative time

Thirty-six of the 53 studies included in this review reported operative time. The operative time showed very wide variations, depending on the technique and surgical team experience. The mean operative time for the repair of unilateral inguinal hernia was 30.1 minutes via the open approach and 23.7 minutes via laparoscopy, with no significant difference between the two techniques ( $P = .33$ ). For the repair of bilateral disease, it was significantly longer for the open technique (46.1 minutes) compared with laparoscopy (30.9 minutes) ( $P = .01$ ).

Considering only the 11 studies comparing OH with the laparoscopic technique,<sup>9,10,12-14,46-48,51,54,55</sup> there was no significant difference in terms of operative time between LH and OH both for unilateral repairs (25.9 versus 25.8 minutes) and for bilateral repairs (25 versus 29.8 minutes) (Table 1).

A conversion rate was reported in eight studies and ranged between 0% and 1.7%, but in the majority of these studies, there was a 0% conversion rate<sup>6,13,18,21,42</sup> (Table 1).

#### Postoperative recurrence and other complications

Major complications are recurrence, hydrocele, wound infection, iatrogenic cryptorchidism, testicular atrophy, and injury to the spermatic cord elements. Forty-three studies reported recurrences: OH values ranged from 0%<sup>13-17,46</sup> to 6%,<sup>51</sup> and LH recurrences ranged from 0%<sup>6,9,11,14,18-25,39,46</sup> to 5.5%.<sup>13</sup> Looking at the averages, there is no significant difference regarding

TABLE 1. OPERATIVE TIME AND CONVERSION RATE OF HERNIA REPAIR PERFORMED VIA THE OPEN OR LAPAROSCOPIC APPROACH

Reference (year)	LH (n)	OH (n)	Operative time (minutes)				Conversion rate
			Monolateral LH	Bilateral LH	Monolateral OH	Bilateral OH	
Parelkar et al. <sup>2</sup> (2010)	576		23	29			
Esposito et al. <sup>4</sup> (2009)	315		18.5	30.5			
Schier <sup>5</sup> (2006)	712		20				
Schier <sup>6</sup> (1998)	22		18				0%
Chan et al. <sup>9</sup> (2005)	42	44	14.7	20.1	12	26.2	
Tsai et al. <sup>10</sup> (2010)	100	57	36	45.5	46	62	
Shalaby et al. <sup>11</sup> (2006)	186		13.2	25.6			
Niyogi et al. <sup>12</sup> (2010)	58	248	42.2	37.5	45.1	66	
Koivusalo et al. <sup>13</sup> (2007)	18	15	39		29		0%
Bharathi et al. <sup>14</sup> (2008)	51	34	25.3		30.6		
Misra et al. <sup>15</sup> (1995)		16			20		
Kamaledeen and Shanbhogue <sup>16</sup> (1997)		24			30		
Usang et al. <sup>17</sup> (2008)		104			41	58	
Esposito and Montupet <sup>18</sup> (1998)	225						0%
Shalaby and Desoky <sup>19</sup> (2002)	169		12.6	14			
Becmeur et al. <sup>20</sup> (2004)	96		25.5	35			
Kaya et al. <sup>21</sup> (2006)	29						0%
Shalaby et al. <sup>22</sup> (2007)	250		10				
Chan <sup>23</sup> (2007)	5		15.2	35			
Chang et al. <sup>24</sup> (2008)	52		31.2				
Yamoto et al. <sup>25</sup> (2011)	92		22.4	30.5			
Schier et al. <sup>26</sup> (2002)	933		16	23			
Gorsler and Schier <sup>27</sup> (2003)	403		14	21			1%–0.25%
Oak et al. <sup>28</sup> (2004)	110		25	35			
Spurbeck et al. <sup>29</sup> (2005)	120		38	47			
Chan et al. <sup>31</sup> (2007)	451		15.7	19.7			
Bharathi et al. <sup>32</sup> (2008)	180		25	40			1%–0.9%
Dutta and Albanese <sup>33</sup> (2009)	275			17			
Lipkar et al. <sup>40</sup> (2010)	241		20.8	26.7			3%–1.7%
Montupet and Esposito <sup>41</sup> (2011)	596		18.5	25.5			
Montupet and Esposito <sup>42</sup> (1999)	47		30				0%
Esposito et al. <sup>46</sup> (2012)	89	11	17.5		20		
Shalaby et al. <sup>47</sup> (2012)	125	125	11.1	14.1	17.3	29.1	
Yerkes et al. <sup>48</sup> (1998)	627	132	44.8	51.6	42.2	48.3	
Esposito et al. <sup>50</sup> (2012)	67		22				
Saha et al. <sup>51</sup> (2013)	30	32	47.6	57.1	28.7	33.5	
Yang et al. <sup>54</sup> (2011)	1543	657	15	20	19	35	
Alzahem <sup>55</sup> (2011)	1300	1399	10	30	14	28	

LH, laparoscopic herniorrhaphy; OH, open herniorrhaphy.

TABLE 2. RECURRENCE RATE AND OTHER COMPLICATIONS FOLLOWING OPEN OR LAPAROSCOPIC HERNIA REPAIR

Reference (year)	LH recurrence	OH recurrence	LH other complications	OH other complications
Parelkar et al. <sup>2</sup> (2010)	14 (2.4%)		Hy 2 (0.35%)	
Esposito et al. <sup>4</sup> (2009)	2 (0.6%)			
Schier <sup>5</sup> (2006)	20 (3.7%)		Hy 3 (0.7%) TA 1 (0.2%)	
Schier <sup>6</sup> (1998)	0 (0%)			
Chan et al. <sup>9</sup> (2005)	0 (0%)		Hy 1 (2.4%)	
Tsai et al. <sup>10</sup> (2010)	1 (0.8%)	1 (1.7%)		WI 1 (1.7%) Cry 1 (1.7%)
Shalaby et al. <sup>11</sup> (2006)	0 (0%)			
Niyogi et al. <sup>12</sup> (2010)	2 (3.4%)	9 (3.6%)	WI 1.49% TA 0%	WI 4 (1.68%) TA 1 (0.56%)
Koivusalo et al. <sup>13</sup> (2007)	1 (5.5%)	0 (0%)		
Bharathi et al. <sup>14</sup> (2008)	0 (0%)	0 (0%)	Hy 2 (5.7%)	Hy 1 (2.9%)
Misra et al. <sup>15</sup> (1995)		0 (0%)		
Kamaledeen and Shanbhogue <sup>16</sup> (1997)		0 (0%)		
Usang et al. <sup>17</sup> (2008)		0 (0%)	WI 5 (4.8%)	
Esposito and Montupet <sup>18</sup> (1998)	0 (0%)			
Shalaby and Desoky <sup>19</sup> (2002)	0 (0%)			
Becmeur et al. <sup>20</sup> (2004)	0 (0%)			
Kaya et al. <sup>21</sup> (2006)	0 (0%)			
Shalaby et al. <sup>22</sup> (2007)	0 (0%)			
Chan <sup>23</sup> (2007)	0 (0%)			
Chang et al. <sup>24</sup> (2008)	0 (0%)			
Yamoto et al. <sup>25</sup> (2011)	0 (0%)			
Schier et al. <sup>26</sup> (2002)	3 (0.3%)		Hy 4 (0.4%) Hy 5 (1.7%) TA 1 (0.25%)	
Gorsler and Schier <sup>27</sup> (2003)	12 (2.9%)		Hy 1 (0.9%) Hy 1 (0.83%)	
Oak et al. <sup>28</sup> (2004)	4 (3.6%)		Hy 2 (0.44%) Hy 6 (3.3%) Hy 2 (0.7%) WI 4 (1.5%)	
Spurbeck et al. <sup>29</sup> (2005)	1 (0.83%)			
Becmeur et al. <sup>30</sup> (2007)	1 (0.47%)			
Chan et al. <sup>31</sup> (2007)	11 (2.44%)			
Bharathi et al. <sup>32</sup> (2008)	9 (5%)			
Dutta and Albanese <sup>33</sup> (2009)	4 (1.5%)			
Kalantari et al. <sup>38</sup> (2009)		5 (1.6%)		
Ehsan et al. <sup>39</sup> (2009)	0 (0%)			
Lipskar et al. <sup>40</sup> (2010)	2 (0.83%)			
Montupet and Esposito <sup>41</sup> (2011)	11 (1.8%)			
Montupet and Esposito <sup>42</sup> (1999)	2 (4.2%)			
Treef and Schier <sup>43</sup> (2009)	32 (3%)			
Nah et al. <sup>44</sup> (2011)	1 (3.5%)	1 (2.8%)		Vas deferens transection 1 (2.8%) Cry 1 (2.8%) TA 2 (5.6%)
Esposito et al. <sup>46</sup> (2012)	0 (0%)	0 (0%)		
Shalaby et al. <sup>47</sup> (2012)	1 (0.8%)	3 (2.4%)	Hy 3 (2.4%) Cry 0 (0%) TA 0 (0%) Cry 4 (5.9%) Hy 1 (3.3%)	Hy 5 (4%) Cry 4 (3.2%) TA 3 (2.4%) WI 0 (0%) Hy 2 (6.6%) TA 6 (2.7%) WI 5 (2.3%) Cry 6 (2.7%)
Esposito et al. <sup>50</sup> (2012)	3 (4.4%)			
Saha et al. <sup>51</sup> (2013)	1 (3.3%)	2 (6%)		
Nagraj et al. <sup>52</sup> (2006)		5 (2.3%)		
Yang et al. <sup>54</sup> (2011)			Hy 2.98% TA 2.1% WI 1.2%	Hy 6.5% TA 2% WI 1.5%

Data are number of subjects (%) as indicated.

Cry, cryptorchidism; Hy, hydrocele; LH, laparoscopic herniorrhaphy; OH, open herniorrhaphy; TA, testicular atrophy; WI, wound infection.

TABLE 3. INCIDENCE AND TYPE OF RARE HERNIAS IDENTIFIED DURING LAPAROSCOPIC HERNIA REPAIR

Reference (year)	Patients	Rare hernias	%
Esposito et al. <sup>4</sup> (2009)	315	1 DH	0.3
Becmeur et al. <sup>20</sup> (2004)	96	3 DH	3.1
Schier et al. <sup>26</sup> (2002)	933	22 DH	2.3
Gorsler and Schier <sup>27</sup> (2003)	403	11 DH	2.7
Becmeur et al. <sup>30</sup> (2007)	212	3 DH	2.3
Schier and Klizaite <sup>34</sup> (2004)	275	2 FH	7.2
		10 DH	
		5 FH	
		3 HP	
		1 IH + FH	
Esposito et al. <sup>45</sup> (2013)	1	1 IH + DH + FH	2.2
Esposito et al. <sup>46</sup> (2012)	89	1 AH	
		2 DH	

AH, Amyand's hernia; DH, direct hernia; FH, femoral hernia; HP, "hernia en pantalon"; IH, indirect hernia.

recurrence rate comparing the two techniques (OH, 1.6% [26 recurrences out of 1539 hernia repairs]; LH, 1.4% [138 recurrences out of 9605 hernia repairs]) ( $P = .66$ ). Analyzing the results only in infants, recurrence rate and wound infections seem to be higher after OH compared with LH.<sup>50-52</sup> Twenty-two studies reported other complications in addition to recurrence.<sup>2,4,5,9,10,11,14,17,26-29,31-33,44,47,50-52,54,55</sup> The rate of these complications such as wound infection, hydrocele, iatrogenic cryptorchidism, and testicular atrophy was significantly higher for OH (2.7%) compared with LH (0.9%)

TABLE 4. INCIDENCE OF CONTRALATERAL PATENT PROCESSUS VAGINALIS IDENTIFIED DURING LAPAROSCOPIC HERNIA REPAIR

Reference (year)	Patients	CPPV incidence (%)
Miltenburg et al. <sup>1</sup> (1998)	964	38.7
Parelkar et al. <sup>2</sup> (2010)	576	19.9
Holcomb et al. <sup>3</sup> (1996)	518	41
Esposito et al. <sup>4</sup> (2009)	315	39
Schier <sup>6</sup> (1998)	22	57.1
Tsai et al. <sup>10</sup> (2010)	100	31
Shalaby and Desoky <sup>19</sup> (2002)	169	7.2
Becmeur et al. <sup>20</sup> (2004)	96	7.3
Schier et al. <sup>26</sup> (2002)	933	38
Gorsler and Schier <sup>27</sup> (2003)	403	45.2
Oak et al. <sup>28</sup> (2004)	110	24.5
Spurbeck et al. <sup>29</sup> (2005)	120	33.3
Chan et al. <sup>31</sup> (2007)	451	39
Tackett et al. <sup>35</sup> (1999)	656	8.8
Handa et al. <sup>36</sup> (2006)	171	22.2
Steinau et al. <sup>37</sup> (2008)	368	6
Kalantari et al. <sup>38</sup> (2009)	301	9.3
Ehsan et al. <sup>39</sup> (2009)	363	39.7
Lipskar et al. <sup>40</sup> (2010)	241	34
Montupet and Esposito <sup>41</sup> (2011)	596	15.9
Nah et al. <sup>44</sup> (2011)	63	54
Esposito et al. <sup>46</sup> (2012)	100	44.9
Yerkes et al. <sup>48</sup> (1998)	759	42.9
Holcomb et al. <sup>49</sup> (1996)	599	46
Saha et al. <sup>51</sup> (2013)	30	66

CPPV, contralateral patent processus vaginalis.

( $P = .001$ ). In particular, five articles reported an incidence of complications such as cryptorchidism and testicular atrophy always higher after OH than after LH ( $P = .001$ )<sup>10,12,44,47,52</sup> (Table 2).

#### Rare hernias

Eight of the 50 studies analyzed in this review reported the incidence of rare hernias, all identified in the LH cohort, with an incidence ranging from 0.3% to 7.2%.<sup>4,20,26,27,30,34,45,46</sup>

As for the incidence of type of rare hernia, the most common of all was a direct hernia (81.5%, 57 patients), followed in order of frequency by femoral hernia (10%, 7 patients), hernia "en pantalon" (4.3%, 3 patients), and a combination of indirect hernia with femoral hernia (1.4%, 1 patient), indirect hernia with direct and femoral hernia (1.4%, 1 patient), and Amyand's/Littrè's hernia (1.4%, 1 patient). No rare hernias were identified in the OH patients (Table 3).

#### Contralateral pathology

Twenty-five studies<sup>1-4,6,10,19,20,26-29,31,35-41,44,46,48,49,51</sup> reported the coexistence of a unilateral inguinal hernia with a contralateral patent processus vaginalis (CPPV), for an incidence of contralateral patency between 19.9%<sup>2</sup> and 66%<sup>51</sup> (Table 4). It is interesting to note that the major occurrence of CPPV was reported in the smaller infants.<sup>51</sup>

#### Discussion

Laparoscopic inguinal hernia repair in children was first described by Montupet in 1993, as noted by Schier.<sup>6</sup> Since then, several retrospective studies but few prospective studies, meta-analyses, or systematic reviews have been published on the subject, and there is ongoing discussion about the best management of an inguinal hernia in children.<sup>7</sup>

An interesting finding in our current review is that the majority of studies published in the last 20 years are focused on the laparoscopic approach. On the other hand, literature focused on inguinal hernia repair is scanty, and we think that the real incidence of complications of inguinal hernia repair is probably underestimated.<sup>41</sup> Our review examined the efficacy and safety of the laparoscopic approach compared with the inguinal crease approach in the management of inguinal hernia in children. The results of this review of 53 studies with regard to operative time suggested that there was no significant difference between the two approaches for unilateral inguinal hernia repair ( $P = .33$ ). In contrast, in patients with bilateral disease, there was a significant reduction in the operative time for LH compared with OH ( $P = .01$ ). However, the operative time showed wide variations depending on the technique and experience of the surgical team.

As for recurrence rate, no significant difference was observed between the two techniques ( $P = .66$ ), whereas the rates of other complications such as wound infections, hydrocele, iatrogenic cryptorchidism, and testicular atrophy were significantly higher for OH compared with LH ( $P = .001$ ). In addition, it seems that recurrence rate and wound infections in infants were always higher after OH than after LH.<sup>50-52</sup> However, the length of follow-up in reviewed series was less for the laparoscopic approach compared with the open operation (2.3 versus 4.2 years, respectively).

In our opinion, the higher wound infection rate following OH may be due to the fact that the laparoscopic scars are located higher on the abdominal wall compared with inguinal scars, which are inside the diaper area; for this reason they are subject to urine or fecal contamination, which may lead to a higher infection rate. In fact, studies of LH reported fewer wound infections compared with the infants of similar age operated on through the inguinal approach (0% for Esposito et al.<sup>50</sup> versus 2.3% for Nagraj et al.<sup>52</sup>).

As for other complications, complications after OH (vas deferens injuries, iatrogenic cryptorchidism, testicular atrophy) have been rarely reported in the last 15–20 years. For this reason, we have had to analyze older published series to gain adequate data for comparison purposes. We found five studies that reported an incidence of postoperative cryptorchidism and testicular atrophy that was higher after OH compared with LH ( $P = .001$ ).<sup>10,12,44,47,52</sup> Accurate comparisons between the two approaches for these other complications suffer from the use of historical controls. Also, there was a shorter follow-up in the LH series compared with the OH ones.

The advantages of LH are believed to include better visualization of vital cord structures, which makes dissection of these structures safer.<sup>28</sup> The dissection field of LH is limited to the peritoneal layer, with the vas deferens and cord left untouched.<sup>28</sup> Therefore, injury to the vas is not thought to occur very often.<sup>28</sup>

This review also reinforces the usefulness of the laparoscopic approach for the diagnosis of contralateral patency, which may avoid the need for a second surgery and anesthesia in patients with a metachronous contralateral hernia.<sup>46,48,49</sup> It is our feeling that repair of a CPPV should be offered to all families as most desire to have the CPPV repaired at the same operative setting.<sup>46,53</sup>

A meta-analysis by Miltenburg et al.<sup>1</sup> showed that laparoscopy has a sensitivity of 99.4% and a specificity of 99.5% regardless of patient age, gender, or side of presentation in detection of CPPV and other various forms of hernia.

In particular, laparoscopy allows a clearer view to identify uncommon hernias such as a direct, femoral, or hernia “en pantalón,” which allows for the appropriate operative technique.

Zendejas et al.<sup>56</sup> found that the risk factors significantly associated with an increased risk of recurrence were direct hernias. In fact, the most common cause of recurrent inguinal OH is a direct hernia, not recognized at the time of initial repair.<sup>56</sup> Laparoscopy should eliminate this issue. As reported by Esposito et al.<sup>57</sup> and Lima et al.,<sup>58</sup> it is extremely easy in laparoscopy to identify a direct hernia. As for the technical point of view, to perform direct hernia repair, first of all, it is important to identify and resect the hernia lipoma (always present); then the surgeon has to close the hernia defect eventually with the aid of the bladder lateral ligament to reinforce the suture.

Another advantage of laparoscopy may be in the management of incarcerated hernias, especially in infants.<sup>44,45</sup> From a technical point of view, the laparoscopic approach is easier but technically more demanding for the surgeon because he or she has to be able to work in a very small space because of the bowel distension. Therefore, it is often useful to perform one or two enemas the day before operation and to use simethicone to empty the intestinal loops of gas and stools, both of which allow the creation of a larger working space in the abdominal cavity.

As for port position, in small infants, we do not have a true triangulation between the optical port and the working instruments because the two operative cannulas are located higher compared with the usual position, as we prefer to position them at the same level as the optical cannulas to create more distance between the ports and the internal inguinal ring.<sup>50</sup>

By adding these technical refinements, LH has become an easy approach in tough repairs such as neonatal inguinal hernias. Analyzing the international literature, it seems that neonatal inguinal LH is easier and with fewer complications compared with inguinal hernia repair.<sup>50,52</sup>

In a randomized study, Chan<sup>23</sup> found that the mean time to resume full activities did not statistically differ between LH and OH, suggesting that recovery after LH is not faster than that after OH in children. In two other studies, similar time to full feeds and length of hospital stay were reported in the LH and OH groups.<sup>44,51</sup>

A meta-analysis by Yang et al et al.<sup>54</sup> demonstrated that LH is superior to OH in the repair of bilateral pathology with a lower rate of metachronous contralateral hernia and a similar operative time for unilateral hernias, length of hospital stay, recurrence, and complication rates.

Another meta-analysis by Alzahem<sup>55</sup> confirmed a shorter operative time for bilateral cases but demonstrated a longer operative time for unilateral cases of LH compared with OH. In addition, it stated a trend toward higher recurrence rate for laparoscopic repair.

One potential disadvantage of LH that is not able to be addressed in this review is the fact that a transabdominal operation is performed with LH when compared with the extraperitoneal approach with the inguinal crease technique. A second disadvantage may be that the laparoscopic incisions, although small, are visible above the underwear/bathing suit line when compared with the inguinal crease incisions. Prospective randomized trials have not been performed on the cosmetic aspects of either approach.

In summary, LH appears faster for bilateral hernia repair when compared with the inguinal crease approach. Recurrence rates appear similar, but the follow-up is less in the LH studies. Wound infection appears more likely after OH, but the incidence is small. Time to resume normal activity is similar with both approaches. Further perspective investigation, including long-term follow-up, will be needed to accurately identify the optimal approach for inguinal hernia repair in infants and children.

In conclusion, we think that there is no evidence in the literature about which technique (laparoscopy or inguinal approach) is preferable to repair an inguinal hernia. Probably a surgeon has to offer to the patient both techniques, and above all, considering the importance of the parental role in the decision process, the parents have to know that two different approaches exist to repair an inguinal hernia and the advantages and disadvantages of both procedures.

#### Disclosure Statement

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