

Variations in open and laparoscopic repair of paediatric inguinal hernia

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ABSTRACT

INTRODUCTION: No recent guidelines exist for surgical treatment of paediatric inguinal hernias. Internationally, there is disagreement about both the preferred approach and the details of the surgical procedure. The aim of this nationwide survey study was to assess variations in Danish surgeons' technique when repairing inguinal hernias in children.

METHODS: A questionnaire was sent to all surgeons in Denmark performing paediatric inguinal hernia repair, including questions about demographic details, choice of open or laparoscopic repair, and technical details of the chosen surgical approach. In the questionnaire, each item was repeated for children aged < 2, 2-12, and 13-18 years of age.

RESULTS: In total, 48 of 59 surgeons responded (81%). For children 12 years of age, the majority of surgeons only performed open repair, whereas none performed laparoscopic repair only. For children aged 13-18 years of age, two thirds of the surgeons performed open repair only, 6% performed laparoscopic repair only and the rest used both methods. We found considerable variations in the execution of both open and laparoscopic repair. The variations regarded incision of the external fascia, nerve identification, division of the cremaster muscle, and exploration of the contralateral groin and repair of an asymptomatic hernia.

CONCLUSIONS: This study found considerable variation in the execution of both open and laparoscopic repair of inguinal hernias in children of different age groups. Research into inguinal hernia repair in children is needed to rationalise and update guidelines in order to improve quality and facilitate research.

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All paediatric inguinal hernias are typically repaired [1]. However, several questions concerning the operative strategy remain unanswered, including choice of open or laparoscopic technique and questions regarding details of the surgical technique in relation to the child's age. An international survey among surgeons performing inguinal hernia repair in children found that 83% preferred open hernia repair, 4% preferred laparoscopic repair and in 13% the choice depended on the child's age and gender [2]. Furthermore, studies have shown large variations in the surgical techniques of open repair in children [3] and laparoscopic repair

in adults [4]. No recent guideline exists for treatment of paediatric inguinal hernias. However, in Denmark, 99.6% of all inguinal hernias in patients under 18 years old from 2005 to 2006 were treated with open surgery [5]. Today, laparoscopic herniorrhaphy is well implemented in adults [6], and perhaps more surgeons also consider it for paediatric inguinal hernias. Furthermore, a recent systematic review showed no difference in post-operative complications for laparoscopic compared with open repair in children [7]. To improve inguinal hernia repair in children, details of the surgical procedures need to be explored.

The aim of this questionnaire study was to assess variations in surgeons' operative technique for inguinal hernia repair in children under 18 years of age in Denmark, and to investigate the reasons for the surgeons' choices.

METHODS

This nationwide cohort study was based on a questionnaire about surgical techniques for inguinal hernia repair in children and reported according to the Strengthening the Reporting of Observational studies in Epidemiology statement [8]. The questionnaire was developed in collaboration with two senior surgeons and created in Research Electronic Data Capture (REDCap), which is a secure web-based application for collecting and managing data in research studies [9]. Face validation of the questionnaire was initially assessed on medical students and medical doctors not performing hernia repairs. Thereafter, a final face validation was performed with a specialist surgeon performing inguinal hernia repairs in children. During the validation process, the questionnaire was tested thoroughly to assess if the questions were comprehended as intended. Surgeons performing paediatric inguinal hernia repair were included in the study. The surgeons were identified by contacting all surgical departments in Denmark to collect names and emails. The questionnaire was sent by email, and non-responders were contacted via email and/or phone call every 5-7 days until contact was made.

The first part of the questionnaire contained questions regarding the surgeons' demographics (age, gender, position, and educational level) and surgical experience (years performing paediatric inguinal hernia repairs and estimated number of repairs performed annually and in total). The second part of the question-

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TABLE 1 / Demographics and experience of the surgeons.

<i>Demographics</i>	
Female/male, n (%)	11 (23)/37 (77)
Age, yrs, median (range)	53 (36-68)
<i>Experience</i>	
Speciality, n (%):	
Surgery	43 (90)
Urology	5 (10)
Position, n (%):	
Head consultant	1 (2)
Consultant	33 (69)
Speciality registrar	14 (29)
Children's age, n (%):	
< 2 yrs	37 (77)
2-12 yrs	48 (100)
13-18 yrs	35 (73)
Repairs, total, n (%):	
1-25	4 (8)
26-50	3 (6)
51-100	14 (29)
101-200	11 (23)
201-300	5 (10)
301-400	3 (6)
401-500	2 (4)
501-600	1 (2)
601-700	0
701-800	1 (2)
801-900	1 (2)
901-1,000	0
> 1,000	3 (6)
Repairs/yr, n (%):	
1-10	16 (33)
11-20	12 (25)
21-30	7 (14)
31-40	0
41-50	10 (20)
51-60	0
61-70	1 (2)
> 70	2 (4)

eral hernias, and male and/or female patients. The second part also contained questions regarding details of the surgical technique, which for laparoscopic repair included: number of ports, choice of transabdominal preperitoneal (TAPP) or total extraperitoneal repair, exploration and repair of a contralateral asymptomatic groin, and use of mesh. For open repair, the questions on surgical technique included: incision of the external fascia, identification of nerves, division of the cremaster muscle, handling of the hernia sac and use of mesh. Finally, surgeons were asked about reasons for avoiding laparoscopy in children, with the choices of: not enough advantages compared with open repair, lack of expertise, prolonged operative time, higher expenses, lack of equipment, fear of complications, patients' preferences, open repair was standard at the department, and other. All questions were repeated for the age groups < 2, 2-12 and 13-18 years old. These intervals were chosen because children < 2 years old are only repaired in a few dedicated hospitals in Denmark, and because a recent publication recommended a different treatment for children who are 12 years old than for children who are 13-18 years old [10].

Data were collected in REDCap and analysed in Microsoft Excel. Categorical data are presented as numbers and percentages, and continuous data are presented as mean and standard deviation if normally distributed and median and range if not. The study was approved by the Danish Data Protection Agency (record number VD-2018-294). No approval from the ethics committee was needed for this study type under Danish law.

Trial registration: not relevant.

RESULTS

We contacted 59 surgeons who met the eligibility criteria from 14 public and five private hospitals. We received completed questionnaires from 48 surgeons (81%), including 37 males and 11 females. The median (range) age of the responding surgeons was 53 years (36-68 years). Characteristics of the included surgeons are presented in **Table 1**. All but five surgeons were specialised in gastrointestinal surgery, three out of four were consultants, and the rest were speciality registrars. All surgeons performed herniorrhaphies on children 2-12 years old, and approximately three quarters performed herniorrhaphies on children < 2 years old and children 13-18 years old. For children < 2 and 2-12 years old, most surgeons performed open repair only, a few performed both open and laparoscopic repair, and none performed laparoscopic repair only. For children 13-18 years old, two thirds only performed open repair, almost a third performed both open and laparoscopic repair, and two surgeons (6%) performed laparoscopic

TABLE 2 / Surgeons' choice of open repair, laparoscopic repair, or both in children of different age intervals. The values are numbers of surgeons (%).

Surgeons' choice	Age group, children		
	< 2 yrs (n = 37)	2-12 yrs (n = 48)	13-18 yrs (n = 35)
Both open and laparoscopic	5 (13.5)	7 (14.6)	10 (28.6)
Only open	32 (86.5)	41 (85.4)	23 (65.7)
Only laparoscopic	0	0	2 (5.7)

naire contained questions to determine in which situations the surgeons would consider open and/or laparoscopic surgery: acute and/or elective repair, primary and/or recurrent hernias, unilateral and/or bilat-

repair only (Table 2). The choice of surgical technique was not affected by the sex of the patients, except for four surgeons who did not perform open repair on girls who are 13-18 years old. Results regarding details of the surgical techniques are presented in Table 3.

Laparoscopic repair

One out of seven surgeons considered laparoscopic repair for children < 2 and 2-12 years of age, while one in three considered laparoscopic repair for children 13-18 years of age. Among the surgeons who considered laparoscopic repair for children > 2 years of age, most performed both acute and elective laparoscopic procedures. For children < 2 years of age, three out of five surgeons considered laparoscopic repair for elective procedures only. More surgeons considered laparoscopic repair for recurrent hernias than for primary hernias, but whether the hernia was unilateral or bilateral did not influence the choice of laparoscopic repair.

Most of the surgeons who considered laparoscopic repair preferred the TAPP method (83%) with three ports (92%) for all age groups. Evaluation of the contralateral asymptomatic side for a patent processus vaginalis was done by 60-83% of the surgeons performing laparoscopic repair (depending on the age group). The answers regarding repair of a contralateral asymptomatic patent processus vaginalis varied greatly. In the 13-18-year age group (where most surgeons considered laparoscopy), 20% answered “yes”, 40% answered “no”, and 40% answered “maybe”. Among the surgeons answering “maybe”, most added in free text: “only if agreed with patients and/or parents beforehand”. No surgeons considered using mesh during laparoscopic repair in children 12 years of age. For children aged 13-18 years, most considered using mesh, but two in three added in the free text: “only if patients are fully- or almost fully-grown”.

The reasons for not using laparoscopy for inguinal hernias in children are presented in Table 4. The top three reasons were, in order: not enough advantages, open repair was standard at the department, and lack of expertise. Furthermore, for children aged 2-12 years and 13-18 years, four (10%) and five (22%) surgeons, respectively, commented that they avoided laparoscopic repair because they did not want to insert a mesh.

Open repair

All surgeons considered open repair for one or more age groups, and most surgeons performed open repair in both acute and elective procedures. More surgeons considered open repair for unilateral hernias than for bilateral hernias, and more surgeons considered open repair for primary than for recurrent hernias.

During open repair, most incised the external fascia with a scissor, but in children < 2 years old, a third

TABLE 3 / Surgeons' choice of operative technique in children of different age intervals. The values are numbers of surgeons (%).

Surgeons' choice	Age group, children		
	< 2 yrs (n = 37)	2-12 yrs (n = 48)	13-18 yrs (n = 35)
<i>Laparoscopic repair</i>	5 (14)	7 (15)	12 (34)
Operation:	32 (86.5)	41 (85.4)	23 (65.7)
Only elective	3 (60)	2 (29)	2 (17)
Only acute	0	1 (14)	1 (8)
Both	2 (40)	4 (57)	9 (75)
Primary hernia:			
Only unilateral	1 (20)	1 (14)	1 (8)
Only bilateral	1 (20)	2 (29)	2 (17)
Both	1 (20)	1 (14)	7 (58)
Recurrent hernia:			
Only unilateral	1 (20)	1 (14)	0
Only bilateral	1 (20)	0	0
Both	3 (60)	6 (86)	11 (92)
Technique:			
TAPP	4 (80)	6 (86)	10 (83)
TEP	1 (20)	1 (14)	1 (8)
Not specified	0	0	1 (8)
Number of ports:			
1	1 (20)	0	0
2	0	0	1 (8)
3	4 (80)	7 (100)	11 (92)
Mesh:			
Yes	0	0 (0)	2 (17)
Maybe	0	0	8 (67) ^a
No	5 (100)	7 (100)	2 (17)
Exploration for cPPV:			
Yes	3 (60)	5 (71)	10 (83)
No	2 (40)	1 (14)	2 (17)
No answer	0	1 (14)	0
Repair of cPPV:			
Yes	1 (33)	1 (20)	2 (20)
Maybe	1 (33)	1 (20)	4 (40)
No	1 (33)	3 (60)	4 (40)
<i>Open repair</i>	37 (100)	48 (100)	33 (94)
Operation:			
Only elective	0	2 (4)	3 (9)
Only acute	2 (5)	0	2 (6)
Both	35 (95)	46 (96)	28 (85)
Primary hernia:			
Only unilateral	3 (8)	14 (29)	13 (39)
Only bilateral	0	1 (2)	0
Both	34 (92)	33 (69)	20 (61)
Recurrent hernia:			
Only unilateral	3 (8)	6 (13)	2 (6)
Only bilateral	0	0	0
Both	22 (59)	26 (54)	13 (39)
Incising external fascia:			
Scissors	21 (57)	32 (67)	27 (82)
Diathermy	2 (5)	2 (4)	2 (6)
Scalpel	0	1 (2)	0
Other	1 (3)	0	1 (3)
No dissection	13 (35)	13 (27)	3 (9)

CONTINUES >>

TABLE 3 CONTINUED / Surgeons' choice of operative technique in children of different age intervals. The values are numbers of surgeons (%).

Surgeons' choice	Age group, children		
	< 2 yrs (n = 37)	2-12 yrs (n = 48)	13-18 yrs (n = 35)
Identification of the ilioinguinal nerve:			
Never	15 (41)	13 (27)	2 (6)
1-25%	9 (24)	8 (17)	4 (12)
26-50%	5 (14)	6 (13)	4 (12)
51-75%	1 (3)	4 (8)	5 (15)
76-100%	7 (19)	17 (35)	18 (55)
Identification of the iliohypogastric nerve:			
Never	20 (54)	21 (44)	6 (18)
1-25%	12 (32)	12 (25)	11 (33)
26-50%	2 (5)	5 (10)	1 (3)
51-75%	2 (5)	4 (8)	6 (18)
76-100%	1 (3)	6 (13)	9 (27)
Identification of the genitofemoral nerve:			
Never	23 (62)	25 (52)	12 (36)
1-25%	12 (32)	14 (29)	7 (21)
26-50%	1 (3)	1 (2)	5 (15)
51-75%	1 (3)	4 (8)	2 (6)
76-100%	0	4 (8)	7 (21)
Dividing the cremaster muscle:			
Yes	6 (16)	7 (15)	7 (21)
No	29 (78)	41 (85)	26 (79)
Other	2 (5)	0	0
Handling of the hernia sac:			
Opening	33 (89)	44 (92)	28 (85)
Invagination	(3)	2 (4)	4 (12)
Other	3 (8)	2 (4)	1 (3)
Handling of the hernia sac if opened:			
Ligature absorbable	9 (27)	14 (32)	7 (25)
Ligature non-absorbable	2 (6)	0	0
Transfixation ligature absorbable	20 (61)	30 (68)	20 (71)
Transfixation ligature non-absorbable	0	0	1 (4)
Internal purse-string	1 (3)	0	0
No answer	1 (3)	0	0
Annulorrhaphy:			
Always	0	0	1 (3)
Often	3 (8)	3 (6)	2 (6)
Sometimes	12 (32)	21 (44)	19 (58)
Never	22 (59)	24 (50)	11 (33)
Mesh use			
	0	0	0

cPPV = contralateral patent processus vaginalis; TAPP = laparoscopic transabdominal preperitoneal inguinal hernia repair; TEP = laparoscopic total extraperitoneal inguinal hernia repair.

a) Only if the patient is fully- or almost fully-grown.

chose not to incise the fascia at all. Also, approximately 25% and 10% did not incise the fascia in children aged 2-12 and 13-18 years, respectively. Regarding nerve identification, the answers varied greatly (Table 3)

with a tendency that the younger the child the more rarely the surgeons identified the nerves. Regardless of the widely varying answers, there were some agreements: for children aged < 2 and 2-12 years, most identified the iliohypogastric nerve and the genitofemoral nerve in less than 25% of the repairs, and for children aged 13-18 years, more than half of the surgeons identified the ilioinguinal nerve in more than 75% of the repairs. Around one in five surgeons divided the cremaster muscle. Most surgeons chose to open the hernia sac and to close the sac with ligature. No surgeons inserted mesh during open repair in children of any age.

DISCUSSION

This nationwide questionnaire study on choices of operative technique for inguinal hernia repair in children showed that open repair was the preferred method. However, wide variations existed regarding the execution of both open and laparoscopic procedure.

The number of surgeons who considered laparoscopic repair for inguinal hernias in children matched an international survey from 2014 where 17% of the surgeons considered laparoscopic repair [2]. In this study, 34% of the surgeons considered laparoscopic repair for children aged 13-18 years, which indicates that it may be increasingly common to perform laparoscopic repair [5]. This development may be unfortunate if not done in a research setting, as the advantages of laparoscopic repair have yet to be established, and a change in surgical approach may initially lead to increased complications and expenses. During unilateral laparoscopic inguinal hernia repair, most surgeons explored the asymptomatic contralateral groin for a patent processus vaginalis, but far from all chose to repair if they found one. It seems reasonable to avoid repair since a contralateral patent processus vaginalis in the asymptomatic groin does not necessarily develop into a clinical hernia [11-13]. However, since it is not indicated to repair the asymptomatic contralateral side, there is also no need for exploration.

Open repair remains the preferred method for paediatric inguinal hernia repair in Denmark as well as worldwide, but the technique varies widely. It is justified to avoid incising the external fascia if the internal ring of the inguinal canal can be visualised sufficiently without doing so, which is the case in newborns and young children as the internal and external rings are close to one another. However, older children have a longer and oblique inguinal canal, which complicates the process of properly inspecting the internal ring and ensuring that the hernia content is reduced without incising the external fascia. Thus, it is notable that some surgeons in this study chose not to incise the external fascia in children aged 13-18 year, as the possibility of a

sufficient reduction in this age group may be questioned. We found large variations regarding identification of nerves during open repair. One study hypothesised that injury to the genitofemoral nerve may cause chronic pain [14], but the importance of nerve identification in children has not been fully explored. In adults, a prospective cohort study found that lack of nerve identification did not increase sensory loss, persistent pain, or affect functional ability six months post-operatively [15]. Nevertheless, the study recommended nerve identification during surgery as the authors believed it to be rational to identify anatomical structures [15]. Accordingly, the large variation concerning nerve identification is comprehensible in light of the lack of evidence. In this study, most surgeons opened and ligated the hernia sac. However, studies have questioned the need for ligation as invagination or excision of the hernia sac may be sufficient [16-18]. The studies did not find an increased risk of complications in relation to ligation, but ligation has been shown to increase post-operative pain in adults [19].

The strengths of this study include the nationwide and anonymised data collection, which reduced the risk of selection bias. Non-response bias was reduced by extensive follow up, which produced a high response rate. The study also has limitations. The look-back design of the study increased the risk of recall bias, e.g. regarding the total number of repairs performed. Another limitation of the study are the predefined age intervals. Answers concerning the choice of operative technique may vary within the same age group, as the children's groins differ anatomically. For instance, large anatomical changes occur from the age of two to the age of 12, and there may also be considerable variations between a 13-year-old boy and an 18-year-old girl.

CONCLUSIONS

In conclusion, most Danish surgeons prefer open repair of inguinal hernias in children. Nonetheless, there are considerable variations in the use of both open and laparoscopic surgical techniques. More research investigating unexplored fields could facilitate evidence-based guidelines, which would likely improve outcomes after inguinal hernia repair in children. However, considering the low complication rates, finding a significant difference between surgical approaches may require an unrealistically large sample size. Thus, we encourage a new guideline based on the present evidence to align treatment across Denmark.

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TABLE 4 / Surgeons' reasons for not using laparoscopic repair. The values are numbers of surgeons (%).

Reason, n (%)	Age group, children		
	< 2 yrs (n = 32)	2-12 yrs (n = 41)	13-18 yrs (n = 23)
Not enough advantages	19 (59)	22 (54)	8 (35)
Open repair was standard at the department	10 (31)	15 (37)	7 (30)
Lack of expertise	9 (28)	12 (29)	8 (35)
Prolonged operative time	1 (3)	2 (5)	1 (4)
Lack of equipment	2 (6)	2 (5)	0
Higher expenses	1 (3)	0	1 (4)
Fear of complications	0	1 (2)	0
Patient or parents' preferences	0	0	0

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