World J Surg (2018) 42:2265–2268
https://doi.org/10.1007/s00268-017-4434-4

ORIGINAL SCIENTIFIC REPORT

Risk Factors for Incisional Hernia in Children

Keiichiro Tanaka[1] · Takeyuki Misawa[1] · Shuichi Ashizuka[1] · Jyoji Yoshizawa[1] · Tadashi Akiba[1] · Takao Ohki[1]

Published online: 29 December 2017

Abstract

Background Incisional hernia (IH) is a major complication of abdominal surgery. Although previous studies reported that the incidence of IH after abdominal surgery in adults was 5–50% and that various independent risk factors were involved, IH in children is still not well known. The objective of our study was to investigate the incidence and risk factors for IH in children.

Methods We retrospectively reviewed all children who underwent abdominal surgery at the Jikei University Hospitals (Jikei University Hospital, Kashiwa Hospital, Katsushika Medical Center and Daisan Hospital) between January 2001 and December 2016. Abdominal surgery in children was defined as open laparotomy and laparoscopic abdominal surgery in patients $\leq$ 15 years old. Conventional open repair for inguinal hernias, umbilical hernia repair, congenital abdominal defect repair and orchiopexy were excluded.

Results Overall, 2049 children were performed abdominal surgery. Among them, 14 children (10 males and 4 females) developed IH, and the incidence of IH was 0.68% (14/2049). There is no significant difference between laparotomy and laparoscopic surgery. The statistically significant variables and identified risk factors were operation in neonates, laparoscopic fundoplication and open supraumbilical pyloromyotomy. In all patients who had IH repair, there was no recurrence during the follow-up period 50.4 months (range 1 months–10 years) except two recurrence cases.

Conclusion The incidence of IH in children is significantly lower than that in adults, and the above three risk factors were revealed. Before abdominal surgery, we recommend that pediatric surgeons should mention the risk of developing IH when the patient has the above risk factors.

Introduction

Incisional hernia (IH) is one of the frequent postoperative complications of open and laparoscopic surgery. IH may present with swelling, pain due to bowel obstruction or skin problems. Although the incidence rate of IH after open abdominal surgery in adults is reported to be 5–50%, the literature on IH in children is limited [1–4]. Our study aims to clarify the incidence and analyze the risk factors for IH in children in our hospital group.

Materials and methods

We retrospectively reviewed all patients who underwent pediatric abdominal surgery at the Jikei University Hospitals (Jikei University Hospital, Kashiwa Hospital, Katsushika Medical Center and Daisan Hospital) between

✉ Keiichiro Tanaka
keiichiro@jikei.ac.jp

[1] Department of Surgery, The Jikei University School of Medicine, 3-25-8, Nishi-Shinbashi, Minato-ku, Tokyo 105-8461, Japan

January 2001 and December 2016. Pediatric abdominal surgery was defined as open and laparoscopic abdominal surgery in patients ≤15 years old, except open repair for inguinal hernia, umbilical hernia repair, congenital abdominal defect (gastroschisis and omphalocele) repair and open orchiopexy for abdominal testis.

Statistical analyses were performed using a statistical program (StatView software version 5.0, SAS institute, Cary, NC, USA). All data were compared using nonparametric statistical analysis with Chi-square and Fischer's exact tests for categorical variables. In all analyses, $p < 0.05$ was considered statistically significant.

Results

Fourteen children (10 males and 4 females) developed IH, among 2049 children who underwent abdominal surgery at our hospitals, and the incidence of IH was 0.68% (14/2049) (Table 1,2). The median age for primary surgical procedure was 2 years and 3 months (range 2 days to 14 years and 4 months) (Table 1). The primary surgical procedure and IH repair were performed under general anesthesia in all patients. All IH patients did not have diabetes, systemic use of steroids, previous abdominal operation, surgical site infection (SSI), malignant tumor, connective tissue disorder and collagen metabolic disorder at the time of primary surgical procedure. The mean age of patients who had IH repair was 3 years and 5 months (range 6 months to 14 years and 7 months) (Table 1). All IH in laparoscopic surgery was rising from 5-mm port site in umbilical portion. According to our records, all IH patients underwent repair surgery for IH at our hospitals.

The details of primary surgical procedure are as follows: gastroesophageal reflux in four, pyloric stenosis in two, and abdominal testis, inguinal hernia, idiopathic thrombocytopenic purpura (ITP), cystic kidney, duodenal atresia, anal atresia, meconium peritonitis and intestinal atresia in one each (Table 3).

Table 1 Details of patients of IH

All IH patients	14
Sex (M:F)	10:4
Age at primary surgical procedure	2 y3 m (2d–14y4 m)
Open:laparoscopic	7:7
Midline open:transverse open	5:2
Age at IH repair	3 y5 m(6 m–14y7 m)
Recurrence	2 cases (14.3%)
Follow-up period	50.4 m (1 m–10 y)

IH incisional hernia

The primary surgical procedure were for laparoscopic fundoplication in three, intestinal anastomosis in two, open supraumbilical pyloromyotomy in two, and open fundoplication, laparoscopy-assisted orchiopexy, laparoscopic percutaneous extraperitoneal closure, laparoscopic splenectomy, laparoscopic nephrectomy, duodenoduodenostomy and stoma creation in one each (Table 3).

The incidence rate of IH was 0.71% (7/986) in laparotomy patients and 0.66% (7/1063) in patients with laparoscopic surgery. There is no significant difference between laparotomy and laparoscopic surgery. Furthermore, we analyzed the age distributions of the patients: neonates 2.42% (4/165), under 1 year 0.88% (6/682), ≤1 year 1.09% (10/915), ≤3 years 1.01% (12/1193) and ≤5 years 0.84% (12/1434). The incidence rate of IH was 2.60% (3/105) in patients laparoscopic fundoplication, and it was 4.26% (2/47) in patients with supraumbilical pyloromyotomy (Table 2). We did not have cases of IH in neonatal patients who underwent laparoscopic surgeries, although we have one IH patient after stoma creation in neonate (Table 2).

The statistically significant variables were operation in neonates, laparoscopic fundoplication and open supraumbilical pyloromyotomy (Table 4). However, there was no statistically significant relationship between IH development and open or laparoscopic surgery (Table 2).

All IH repairs were performed by resecting the hernia sac, and absorbable sutures were used to close the peritoneum and fascia separately without artificial mesh. Standard office follow-up for all patients after IH repair was 2 weeks from hospital discharge. Subsequent follow-up was by the referring clinician. In all patients who had IH repair, there was no recurrence during the follow-up period of 50.4 months (range 1 month to 10 years) except two recurrence cases (14.3%) (Table 1). Two recurrent patients do not desire the repair operation.

Discussion

IH is a commonly reported complication following abdominal surgical procedures. The incidence rate of IH in adults after open abdominal surgery 5–50% depends on the type of incision, patient group and closure technique [1, 2]. Previous studies of IH in adults reported various independent risk factors, including sex, advanced age, high body mass index, emergency surgery, SSI, malignant tumor, diabetes, collagen metabolic disorder and chronic obstructive pulmonary disease [1, 2, 5]. Dietz UA et al. [5] reported risk factors, recurrence rating, morphology and hernial gap size, and classified IH in a retrospective study of 330 adult patients (>18 years). It is reported that the incidence of IH in children is lower than that in adults, with

Table 2 Comparison of patients with or without IH

	IH	No IH	Total	Rate (%)	*p* value
All patients	14	2035	2049	0.68	
Open	7	979	986	0.71	NS
Laparoscopic	7	1056	1063	0.66	NS
Primary surgical procedure in neonate	4	161	165	2.42	0.017
Primary surgical procedure under 1 year	6	676	682	0.88	NS
Primary surgical procedure in <1 year	10	905	915	1.09	NS
Primary surgical procedure in <3 years	12	1181	1193	1.01	NS
Primary surgical procedure in <5 years	12	1422	1434	0.84	NS
Laparoscopic fundoplication	3	102	105	2.80	0.046
Open supraumbilical pyloromyotomy	2	45	47	4.26	0.048
Laparoscopic in neonate	0	7	7	0	NS
Stoma creation in neonate	1	37	38	2.63	NS

Table 3 Details of primary surgical procedure of patients of IH

Diagnosis for primary surgical procedure		Primary surgical procedure	
Gastroesophageal reflux	4	Laparoscopic fundoplication	3
Pyloric stenosis	2	Intestinal anastomosis	2
Abdominal testis	1	Open supraumbilical pyloromyotomy	2
Inguinal hernia	1	Laparoscopic percutaneous extraperitoneal closure	1
Idiopathic thrombocytopenic purpura (ITP)	1	Laparoscopic splenectomy	1
Cystic kidney	1	Laparoscopic nephrectomy	1
Duodenal atresia	1	Duodenoduodenostomy	1
Anal atresia	1	Stoma creation	1
Meconium peritonitis	1	Laparoscopy-assisted orchiopexy	1
Intestinal atresia	1	Open fundoplication	1

IH: incisional hernia

Table 4 Results of multivariate stepwise logistic regression analyses

Risk factors	Odds ratio	95% CI for OR		*p* value (OR)
		Lower limit	Upper limit	
Primary surgical procedure in neonate	3.61	1.24	10.57	0.017
Laparoscopic fundoplication	4.28	1.3	14.13	0.046
Open supraumbilical pyloromyotomy	6.46	1.6	26.35	0.048

an incidence of 2.1–3.2% [1, 4]. However, there is a paucity of data related to IH in children [1, 3, 4].

Our study included over 2000 patients who were investigated for IH after abdominal surgery in four hospitals for the span of 16 years. In this study, the risk factors for IH are neonatal operation, laparoscopic fundoplication and open supraumbilical pyloromyotomy.

Our data indicated that neonatal operation is one of the risk factors for IH. The previous studies report that laparotomies in neonate and younger children were the high risk of IH in children [1, 2]. Talbot et al. [6] reported

that IH was a significantly common complication after neonatal stoma creation at low weight. We have one neonate who developed IH after creation of stoma, but it is not statistically significant.

Furthermore, the current study demonstrated that laparoscopic fundoplication is one of the risk factors for IH. The additional reports that followed showed an overall incidence of 0–3%; however, there are few reports of children case [7–10]. Our three cases of IH after laparoscopic fundoplication were neurologically impaired children. We think that the atrophy of rectus muscles by neurological impairment is related to the risk factor for IH.

In addition, our data revealed that open supraumbilical pyloromyotomy was a high-risk procedure for developing IH. IH is major complications following supraumbilical pyloromyotomy in 1–2% of cases [1, 11, 12]. We suggest that there is relation between high risk factor for IH and malnutrition caused by pyloric stenosis.

The European Hernia Society published guidelines to decrease the incidence of IH.

They recommended utilization of a non-midline approach to a laparotomy whenever possible [1, 13]. Moreover, with regard to method of abdominal closure, they suggested to use slowly absorbable monofilament suture through a single-layer aponeurotic closure technique without separate closure of the peritoneum. For laparoscopic surgery, they suggested to use smallest trocar size suitable for the procedure and closure of the fascial defect if trocars larger or equal to 10 mm are used [1, 9]. However, Mullassery et al. [1] reported two cases of IH from 3-mm port site in pediatric laparoscopy. In children, the abdominal wall is rather thin and the abdominal muscles are weak, and even oblique trocar insertion passes nearly straight through the abdominal wall. To prevent IH of trocar site in children, we recommended fascial closure of all trocar sites even if less than 3 mm and reduced the port in pediatric laparoscopic surgery.

In conclusion, the incidence of IH in children is significantly lower than that in adults. Given the limitations of retrospective study, there is a necessary to conduct a multicenter prospective study to examine the natural history and risk factors for IH in children. Further particulars reports and meta-analyses are necessary to clarify the true role of IH in children. Our study indicated that the risk factors for IH are neonatal operation, laparoscopic fundoplication and open supraumbilical pyloromyotomy. These are completely different risk factors from that of IH in adults. We recommend that the abdomen is sutured closely in these operations. Furthermore, pediatric surgeons should not fail to inform IH and its risk factors when obtaining informed consent for abdominal surgery.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest and received no financial support for this work.

References

1. Mullassery D, Pedersen A, Robb A, Smith N (2016) Incisional hernia in pediatric surgery-experience at a single UK tertiary centre. J Pediatr Surg 51(11):1791–1794
2. Itatsu K, Yokoyama Y, Sugawara G, Kubota H, Tojima Y, Kurumiya Y, Kono H, Yamamoto H, Ando M, Nagino M (2014) Incidence of and risk factors for incisional hernia after abdominal surgery. Br J Surg 101(11):1439–1447
3. Paya K, Wurm J, Fakhari M, Felder-Puig R, Puig S (2008) Trocar-site hernia as a typical postoperative complication of minimally invasive surgery among preschool children. Surg Endosc 22(12):2724–2727
4. Cost NG, Lee J, Snodgrass WT, Harrison CB, Wilcox DT, Baker LA (2010) Hernia after pediatric urological laparoscopy. J Urol 183(3):1163–1167
5. Dietz UA, Winkler MS, Härtel RW, Fleischhacker A, Wiegering A, Isbert C, Hurowich CP, Heuschmann P, Germer CT (2014) Importance of recurrence rating, morphology, hernia gap size, and risk factors in ventral and incisional hernia classification. Hernia 18(1):19–30
6. Talbot LJ, Sinyard RD, Rialon KL, Engulum BR, Tracy ET, Rice HE, Adibe OO (2017) Influence of weight at enterostomy reversal on surgical outcomes in infants after emergent neonatal stoma creation. J Pediatr Surg 52(1):35–39
7. Bowrey DJ, Blom D, Crookes PF, Bremner CG, Johansson JLM, Lord RV, Hagen JA, DeMeester SR, DeMeester TR, Peters JH (2001) Risk factors and the prevalence of trocar site herniation after laparoscopic fundoplication. Surg Endosc 15(7):663–665
8. Miyano G, Yamoto M, Morita K, Kaneshiro M, Miyake H, Nouso H, Koyama M, Nakajima H, Fukumoto K, Urushibara N (2015) Laparoscopic toupet fundoplication for gastroesophageal reflux: a series of 131 neurologically impaired pediatric cases at single children's hospital. Pediatr Surg Int 31(10):925–929
9. Mahmoud HY, Ustumer EH, Sozener U, Ozis SE, Turkcapar AG (2007) Cannula site insertion technique prevents incisional hernia in laparoscopic fundoplication. Surg Laparosc Endosc Percutan Tech 17(4):267–270
10. Dhaou MB, Zouari M, Chtourou R, Zitouni H, Jallouli M, Mhiri R (2017) Incidence of incisional hernia after single-incision laparoscopic surgery in children. J Min Access Surg 13(3):240–241
11. Van den Ende ED, Allema JH, Hazebroek FWJ, Breslau PJ (2007) Can pyromyotomy for infantile hypertrophic pyloric stenosis be performed in any hospital? Eur J Pediatr 166(6):553–557
12. Mullassery D, Shariff R, Craigie RJ, Losty PD, Kenny SE, Baillie CT (2007) Umbilical pyloromyotomy: comparison of vertical linea alba and transverse muscle cutting incisions. J Pediatr Surg 42(3):525–527
13. Muysoms FE, Antoniou SA, Bury K, Campanelli G, Conze J, Cuccurllo D, De Beaux AC, Deerenberg EB, East B, Fortelny RH, Illion JF, Henriksen NA, Israelsson L, Jairam A, Jänes A, Jeekel J, López-Cano M, Miserez M, Morales-Conde S, Sanders DL, Simons MP, Śmietański M, Venclauskas L, Berrevoet F (2015) European hernia society guidelines on the closure of abdominal wall incisions. Hernia 19(1):1–24