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PAPER

A.M. Fette · M.E. Höllwarth

Special aspects of neonatal inguinal hernia and herniotomy

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Abstract In a retrospective study, we examined 23 pre-term infants (18 boys, 5 girls) with a median weight of 1540 g (range 720–2770 g) and a median age of 32 weeks (range 25–36 weeks) gestation, who were subsequently operated on after a median of 65 days (range 20–121 days) for 33 inguinal hernias. The infants were evaluated with respect to concomitant diseases as well as peri- and postoperative complications. The following surgical procedure was used in all patients: a high suture ligation after excision of the hernia sac, followed by closure of the groin according to Grob in boys, and according to Bassini in girls. Co-morbidity was high in the pre-term infants, both pre- and perinatally. Despite this high co-morbidity and a high rate of emergency operations due to incarcerations, the postoperative complication rate was very low. However, the rate of testicular atrophy (10%) and recurrent inguinal hernia (9%) registered by us in the median follow-up of 575 days (range 105–1118 days) was much higher than that seen in older infants. Nevertheless, based on the low perioperative complication rate registered in the present study, we postulate that early surgery is tenable in pre-term infants despite the high co-morbidity and is even meaningful for the purpose of reducing the high rate of incarceration and testicular atrophy. The high recurrence rate in pre-term infants appears to be related to the numerous concomitant diseases in these patients, the resultant increase in intra-abdominal pressure and the small size of anatomical structures.

Keywords Inguinal hernia · Pre-term infants · Special aspects

A.M. Fette (✉) · M.E. Höllwarth
Department of Pediatric Surgery,
University of Graz, Medical School,
Auenbruggerplatz 34, 8036 Graz, Austria
E-mail: andreas.fette@gmx.de
Tel.: +43-316-3853762

Introduction

The open vaginal process of the peritoneum that plays a key role in intrauterine descent of the testicles from the abdominal cavity into the scrotum is the anatomical basis of congenital pediatric inguinal hernia [7, 22]. The emergence of inguinal hernia during the development of the groin is, however, attributed to the increase in abdominal pressure as a result of concomitant systemic diseases [14, 22]. As the vaginal process of the peritoneum is still entirely open in pre-term infants and as such infants often have several concomitant systemic diseases associated with an increase in abdominal pressure, the incidence of inguinal hernia in pre-term infants is as high as 13–30%, according to published data [1, 3, 10, 14, 22, 37]. This high incidence makes inguinal hernia the most common indication for surgery in pre-term infants. The purpose of the present study was to elucidate special aspects of inguinal hernia and herniotomy in these infants.

Patients and methods

From October 1995 through to February 1998, we operated on 23 pre-term infants (18 boys and 5 girls) with 33 inguinal hernias. Their median age was 32 weeks (range 25–36 weeks) gestation and their birth weight, 1540 g (range 720–2770 g). Infants with asymptomatic inguinal hernia were operated on electively, shortly before they were transferred from the neonatal intensive care unit to the regular ward. In the event of incarceration, a primary reduction was attempted. If this was successful, the planned operation was performed about 48 h later. Irreducible inguinal hernias were operated on immediately. The standard procedure used in all pre-term infants was high suture ligation after excision of the hernia sac, followed by closure of the groin according to Grob in boys and according to Bassini (modified) in girls.

- Grob's procedure. Exposure of external inguinal ring, dissection of external oblique fascia, mobilization of the neck of the hernial sac with high suture ligation, interrupted sutures between oblique internal muscle and inguinal ligament, closure of the oblique external fascia

- Bassini's procedure (Prof. Sauer's modification). High suture ligation of the hernial sac under separation of lig. teres uteri, suture draws cranial through oblique external fascia and internal muscle and again the margin of external oblique fascia, caudal broad grasp of inguinal ligament, closure of caudal to cranial part of the external oblique fascia with interrupted sutures.

In cases of bilateral hernia, the surgeon decided whether to perform surgery in a single session or as a two-step procedure. Routine exploration of the contralateral side in cases of clinically evident unilateral inguinal hernia was not generally undertaken. Based on the patient's history and in the course of an ambulatory examination, the pre-term infants were followed up with regard to their herniotomy, postoperative course and subsequent development. The data are expressed as percentage prevalences, medians and ranges.

Results

Approximately one-third of the mothers in our patient collective had severe metabolic diseases and/or risk factors. Nearly one-half of the mothers had pregnancy-related complications (Table 1 and Table 2).

Seven children (30%) were delivered by Caesarian section and three (13%) were born in the course of twin births. In two cases (8%), a feto–fetal transfusion syndrome occurred. One pre-term infant (4%) had to be resuscitated during delivery. In addition to these pre- and perinatal factors that favored the development of inguinal hernia, the pre-term infants very frequently had severe concomitant diseases associated with an increase in intra-abdominal pressure. Pulmonary diseases in particular were present in up to 43% of the patients (Table 3). Specific connective tissue diseases were not seen in the present patient population. None of the pre-term infants had undergone a laparotomy before the herniotomy.

At the initial examination, 12 (52%) hernias were on the right side, seven (31%) were bilateral and four (17%) were located on the left side. Three (13%) of the pre-term infants subsequently developed a hernia on the contralateral side; in two children, this appeared on the left side and in one on the right side. Six (26%) pre-term infants had an irreducible, incarcerated hernia that required emergency surgery. Five children with asymptomatic bilateral hernia were operated on in a single-step, and two children with bilateral hernia in a two-step procedure. Surgery on the contralateral side was performed 2 weeks after the initial operation. At the time of surgery, the median postpartal age of the infants was 65 days (range 20–121 days) and their weight 2540 g (range 1820–6260 g). At the premedication visit, one pre-term infant (4%) was assigned to ASA (American Society of Anesthesiology) category I, 16 (59%) to ASA category II and 10 (37%) to ASA category III (Table 4). Anesthetic complications were not encountered.

Intraoperatively, only indirect hernias were found. Direct hernias or combinations of direct and indirect hernias did not appear in our patient collective. In 14 herniotomies (42%), an edematous hernia sac was isolated, and three children (9%) had an extensive hydrocele. In seven boys (26%), the hernia sac contained the testicles, in one girl (17%) the ovary, in three children (9%) portions of the bowel and appendix. In none of the operations was bowel resection or removal of the gonads required. A uniform surgical procedure was used, con-

Table 1 Metabolic diseases and risk factors of the mothers (multiple denominations possible)

HELLP syndrome	2
Diabetes mellitus	1
Arterial hypertension	1
Epilepsy	1
Alcoholism	2

Table 2 Pregnancy-related complications (multiple denominations possible)

Early rupture of membranes	5
Placenta previa	2
Vaginal hemorrhage	3
Threatened abortion	1

Table 3 Concomitant diseases of our pre-term infants (multiple denominations possible)

	n	%
Resuscitation	1	4
Feto–fetal transfusion syndrome	2	8
Sepsis	4	17
Metabolic diseases	6	26
Apnea	10	43
Asphyxia	2	8
Pulmonary hemorrhage	4	17
Pneumonia	2	8
Pneumothorax	1	4
Wet lung	1	4
Infant respiratory distress syndrome	6	26
Cardiomyopathy	1	4
Atrioventricular septal defects	1	4
Persistent ductus arteriosus	3	13
Subependymal hemorrhage	6	26
Intraventricular hemorrhage	2	8
Cerebral palsy	2	8
Fits	1	4
Hydronephrosis	2	8
Renal insufficiency	1	4
Single kidney	1	4
Hypospadia	1	4
Umbilical hernia	2	8
Constipation, neuronal intestinal dysplasia	2	8
Gastro-esophageal reflux disease (GERD)	1	4

Table 4 Summary of anesthetic procedures

	n = 26	%
Endotracheal anesthesia	8	31
Endotracheal/caudal anesthesia	5	19
Endotracheal/regional anesthesia	1	4
Inhalation/caudal anesthesia	4	15
Sedation/caudal anesthesia	8	31

sisting of excision of the hernia sac with a high suture ligation and closure of the groin according to Grob in boys or according to Bassini in girls. If required, an orchidopexy or removal of the hydrocele was performed additionally. Perioperative complications were not encountered in our population. After a brief stay at our department, the pre-term infants could be discharged or transferred to the pediatric department the day after surgery. Postoperative complications such as hematoma, hemorrhage, wound infection or wound healing disorders did not occur.

Twenty-one (91%) of our operated pre-term infants could be followed up after a median of 575 days (range 105–1118 days). We diagnosed three recurrent inguinal hernias, which signified a recurrence rate of 9% for the entire population. One male and extremely premature infant developed bilateral recurrent hernia 14 weeks after a two-step herniotomy. The operation for the recurrent hernia in this patient has not yet been performed. One further male patient had an indirect recurrent inguinal hernia at the follow-up and at the repeat operation performed 6 months after initial surgery. Having undergone repeat surgery with the same surgical technique, the child is still free of recurrence. None of the girls we operated on developed a recurrent hernia. Testicular atrophy of the ipsilateral side was seen in two boys (10%). One inguinal testicle in the contralateral side after surgery for hydrocele was seen in one boy. Discrete bilateral hydroceles were observed in four boys (22%) in the follow-up period (Table 5).

Discussion

As a result of their physical immaturity and numerous concomitant diseases, pre-term infants have a high rate of co-morbidity, often associated with cardiopulmonary and respiratory complications [6, 15]. In concordance with the authors who reported this, a high rate of co-morbidity was observed in our pre-term infants as a result of both pre- and perinatal complications and concomitant cardiopulmonary and cerebral diseases. Some authors suggest that inguinal herniotomy be performed as late as possible in pre-term infants [6, 15] because of the frequently reported severe intra- and perioperative complications, such as cardiac arrest, sepsis and respiratory insufficiency, occasionally with a fatal outcome [1, 14, 16, 19, 25]. However, the contrary is postulated by some authors who observed a low complication rate [18] and even an improvement in respiratory function in pre-term infants who had been operated on early [4]. The approach to perform surgery as early as possible is supported by the fact that the frequency of incarceration of the contents of the hernia sac is highest during the first few weeks of the life of pre-term infants (between 7% and 31%) [10, 16, 19, 25, 29] and is associated with a markedly high rate of complications and morbidity (up to 5%) [1, 5, 8, 16, 19, 20, 21, 22, 25, 28, 29, 31]. Six (26%) of our pre-term infants had an irreducible incarcerated hernia. However, no infant required bowel resection and no postoperative complications were encountered.

In a large surveillance study concerning the commonly used procedures for elective herniotomy in pre-term infants and infants born at term, the authors recommend a minimum weight of 2200 g and a post-conception age of 40–60 weeks at the time of surgery [32]. In cases of inguinal hernia appearing during the course of hospitalization, the majority of pediatric surgeons reported having operated on their patients before the latter were discharged from the neonatal intensive care unit, provided the infant's weight was more than 1000 g and age more than 29 weeks post-conception [32]. In the event of incarceration, in most cases a primary reduction was attempted first. If this was successful, the planned operation was performed within 48 h. The most frequently used surgical technique was high suture ligation of the hernia sac. In pre-term infants with asymptomatic inguinal hernia, we also performed the operation before the patients were transferred from the neonatal intensive care unit to the regular ward. Their median age on the day of surgery was 65 days (range 20–121 days) post-partum and their weight 2651 g (range 1820–4820 g). In cases of incarcerated hernia, we also first attempted reduction. If this was successful, the planned operation was performed after 48 h. Patients with irreducible incarcerations were subjected to emergency surgery. Pre-term infants undergoing emergency surgery had a median weight 3020 g (range 2190–4820 g) on the day of surgery and were 68 days (range 20–96 days) old post-partum. The surgical technique we used was high suture ligation and closure of the groin according to Grob in boys, and according to Bassini in girls.

In a large study, 70% of the interviewed pediatric surgeons reported having operated on their patients using general anesthesia, whereas 11% had used caudal anesthesia [32]. According to Conroy et al., caudal anesthesia permits more early surgery, as it allows early extubation or circumvents such extubation and, in addition, significantly reduces the need for postoperative painkillers in these high-risk patients [2]. We have been using caudal anesthesia as well as our pediatric anesthetics increasingly often, with a high rate of success and with no perioperative complications.

Due to high incidence of contralateral hernia, some authors recommend routine exploration of the contralateral side in cases of evident unilateral groin hernia,

Table 5 List of complications

	n	%
Irreducible, incarcerated hernias	6	26
Recurrent hernias	3	9
Ipsilateral testicular atrophy	2[a]	10
Bilateral hydroceles	4	22

[a]One emergency operation due to incarceration, one bilateral cryptorchismus

with a view to avoiding additional and often rather early repeat surgery [16, 25]. Other authors make this decision dependent on further clinical symptoms, the patient's age and/or gender [14, 26, 27]. Yet other authors advise, on principle, no routine exploration of the contralateral side [1, 17, 19, 30]. Their concern is that the prolonged operation time and the fact that unnecessary surgery would be performed in cases of no hernia on the contralateral side may have deleterious effects on the pre-term infants and increase perioperative complications [19] as well as the rate of iatrogenic injury to the spermatic cord, eventually leading to infertility [28, 31]. At the present time, neither clinical nor radiological investigation procedures provide an adequately reliable means of excluding a contralateral inguinal hernia [11, 12, 13, 35]. Intraoperative placement of a pneumoperitoneum, the Goldstein test [21], as well as laparoscopic exploration of the contralateral side offer novel diagnostic options [11, 12, 33]. However, these methods have been rarely used [32] and their application in pre-term infants has not been attempted so far. In our patients, a contralateral inguinal hernia was excluded by clinical examination alone.

Pediatric patients usually have direct inguinal hernias; these are extremely rare [9, 34, 36]. We also observed only indirect hernias and no direct hernias. Based on the frequency of indirect hernias with an intact posterior wall of the inguinal canal, high ligation of the hernia sac is recommended as the surgical method of choice, both in the literature as well as in surgical practice. Only in cases of an extremely wide inner inguinal ring is additional constriction advised. Reconstruction of the posterior wall of the inguinal canal is usually not performed [8]. In all our operations, the inguinal canal was opened, the hernia sac exposed and a high, absorbable ligation of the hernia sac performed. The groin was closed according to Grob's procedure in boys and according to Bassini's procedure in girls. Constriction of the inner inguinal ring and further exploration of the posterior wall of the inguinal canal were not performed.

According to the literature, specific postoperative complications such as hematoma and wound infection are very rare. However, in cases of incarceration requiring bowel resection, complications are reported to be as high as 5% [1, 5, 16, 19, 20, 22, 25, 29, 31]. In concordance with other authors, we observed no bowel damage, hematoma or wound infection [16]. The rate of testicular asymmetry after inguinal herniotomy without previous incarceration is approximately 10% [16]. In another study, shrunken testicles were seen in 5.8% of cases and the rate of testicular atrophy was 1% [30]. In a study in patients with proven incarceration, a testicular atrophy rate of 5% was reported [26]. Misra et al. investigated 59 incarcerated hernias in pre-term infants and observed 2 testicular atrophies, with 1 testicle requiring emergency excision [19]. During the follow-up period, we found 2 ipsilateral testicular atrophies after one initially reducible and one irreducible inguinal hernia, respectively. Furthermore, we observed one iatrogenic elevated testis in the contralateral side after a hydrocele operation. According to published literature, the rates of iatrogenically induced elevated testes after inguinal herniotomy in children have been reported as 0.3% [31], 2.3% [23] and 3% [30].

The recurrence rate after inguinal herniotomy in pre-term infants is generally considered to be higher than that for older infants, although comparative studies focusing on this subject have not yet been published. Misra and co-workers examined children less than 6 months of age, of which 36% were pre-term infants, and reported a recurrence rate of 1.9% [19]. Rajput et al. reported a recurrence rate of 2.6% in very-low-birthweight infants operated on 28 weeks postnatally [24]. In our patients, all of whom were pre-term infants, a recurrence rate of 9% was registered. With respect to girls, Grosfeld et al. reported one patient with several recurrences, but described her as an exceptional case [9]. Other authors have reported no recurrent inguinal hernia in girls [35]. This is in agreement with our results. Connective tissue diseases and an increase in intra-abdominal pressure as a result of concomitant diseases are regarded as potential co-factors for the appearance of recurrent inguinal hernia. Errors in surgical technique – such as incorrect positioning of the ligature at the base of the hernia sac; an unconstricted, widely open inner inguinal ring; an undetected concomitant direct hernia or iatrogenic injury to the posterior wall of the inguinal canal – may also lead to recurrent hernia. Postoperative complications such as hematoma or wound infection additionally favor recurrent hernia [9, 31, 35]. In view of the fact that we used the same surgical technique in children of all age groups, the size of anatomical structures and the numerous concomitant diseases in pre-term infants appeared to have had a substantial influence on the high recurrence rate in our pre-term infants compared with other age groups. Wound infection or hematoma were not encountered in the present study. Grosfeld and co-workers reported in their studies that 4.2% of recurrences occurred during the patient's hospitalization, 50% within 6 months and 76% within 2 years postoperatively [9]. Our pre-term infants developed a left-sided recurrence after about 8 weeks; in the second case, a bilateral recurrent hernia appeared after about 14 weeks.

Conclusion

The present retrospective study confirmed the high co-morbidity in pre-term infants as a result of peripartal complications, physical immaturity and several concomitant diseases. Such co-morbidities appear to have a significant influence on the appearance of inguinal hernia and on herniotomy. Early surgery to avoid incarceration and/or strangulation of the contents of the hernia sac with its consequences seem to be meaningful because of the high rate of testicular atrophy and also seem to be feasible in view of the low rate of surgical

complications encountered in the present study. The anesthetic procedure of choice is, in our experience, caudal anesthesia. The frequent concomitant diseases in pre-term infants, which are associated with an increase in intra-abdominal pressure, and the small size of anatomical structures are, in our opinion, responsible for the high recurrence rate in our pre-term infants, since the same surgical procedure was associated with a markedly lower recurrence rate in older infants.

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