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ORIGINAL ARTICLE

Age-dependent outcomes in asymptomatic umbilical hernia repair

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Abstract

Purpose Umbilical hernias are common in young children. Many resolve spontaneously by age four with very low risk of symptoms or incarceration. Complications associated with surgical repair of asymptomatic umbilical hernias have not been well elucidated. We analyzed data from one hospital to test the hypothesis that repair at younger ages is associated with increased complication rates.

Methods A retrospective chart review of all umbilical hernia repairs performed during 2007–2015 was conducted at a tertiary care children's hospital. Patients undergoing repairs as a single procedure for asymptomatic hernia were evaluated for post-operative complications by age, demographics, and co-morbidities.

Results Of 308 umbilical hernia repairs performed, 204 were isolated and asymptomatic. Postoperative complications were more frequent in children < 4 years (12.3%) compared to > 4 years (3.1%, $p = 0.034$). All respiratory complications ($N = 4$) and readmissions ($N = 1$) were in children < 4 years.

Conclusions Age of umbilical hernia repair in children varied widely even within a single institution, demonstrating that timing of repair may be a surgeon-dependent decision. Patients < 4 years were more likely to experience post-operative complications. Umbilical hernias often resolve over time and can safely be monitored with watchful waiting. Formal guidelines are needed to support delayed repair and prevent unnecessary, potentially harmful operations.

Keywords Umbilical hernia · Pediatric surgery · De-intervention · Herniorrhaphy · Surgical complications

Abbreviations

ICD-9	International classification of diseases, ninth revision
CPT	Current procedural terminology
FDA	Food and Drug Administration
ASA	American Society of Anesthesiologists

Introduction

Pediatric umbilical hernias are extremely common, with a prevalence of 15–23% in newborns [1, 2]. Despite their prevalence, literature describing the natural history and indications for repair of asymptomatic umbilical hernias is limited. Existing data suggest that early operative closure may result in unnecessary operations, as up to 90% of umbilical hernias close spontaneously [3]. There is a wide range of recommendations regarding the optimal timing for elective repair of asymptomatic umbilical hernias [4]. Minimum age recommendations in the few published cohort studies range from children over 2 years to children 10–12 years [5–12]. A review of websites of American children's hospitals found recommendations for minimum age of surgery ranging from 2 to 5 years [4]. Although umbilical hernia repair is the most common elective general surgery procedure performed in children between 1 and 17 years old [13], there are no formal management guidelines from major pediatric medicine organizations including the American Academy of Pediatrics, the American Pediatric Surgical Association, and the

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American College of Surgeons. While umbilical hernia repair is a comparatively low-risk procedure [7, 10, 11, 14], it is important to consider the associated risks of anesthesia and respiratory complications in very young children [15–19]. Premature operative repair of defects with a high likelihood of spontaneous closure places an unnecessary resource burden on healthcare systems, and unnecessary financial pressure on parents, insurers, and society.

All previously published literature describing complications of umbilical hernia repair in children has included symptomatic or complicated hernia repairs. To date, no study has specifically examined age-dependent complication rates in children with asymptomatic umbilical hernias who undergo repair. Thus, the true postoperative complication rates for elective, uncomplicated pediatric umbilical hernia repair, and the effect of patient age on post-operative complications, are unknown. The aim of this study was to describe operative decision-making and complications in children undergoing repair of asymptomatic umbilical hernias as an isolated procedure and to test the hypothesis that younger children undergoing repair are more likely to experience post-operative complications.

Materials and methods

A primary chart review was performed at our tertiary children's hospital for children, aged 17 years or younger, undergoing umbilical hernia repair, as defined by International Classification of Diseases, Ninth Revision (ICD-9) procedure codes 53.49 and 53.41, from 2007 to 2015. Because umbilical hernia repairs are sometimes undertaken incidentally while performing other procedures, we included only those undergoing umbilical hernia repair as a single, isolated procedure. Children with complicated umbilical hernias were also excluded, specifically those with episodes of acute incarceration or strangulation (ICD-9 diagnosis codes of 551.1 and 552.1). The size of the hernia defect was abstracted from operative notes, and complication rates were abstracted from anesthesia records and postoperative provider notes. Timing of repair and indication for repair were obtained based on an analysis of clinic and operative notes. All provider notes in the facility electronic health record for the first 1 month postoperatively were reviewed to determine if the patient experienced any post-operative complications including wound complications, emergency room visits, readmissions or infections. Long-term follow-up was assessed by examining the most recent available provider notes including an abdominal exam to assess for recurrence rate, chronic pain or cosmetic complication related to scar formation. Provider notes were examined for complications over the course of no less than 1 year postoperatively. The study protocol was approved by our Institutional Review Board.

Statistics

Statistical analysis was performed using SPSS™ v.23 (IBM©, Armonk, New York) software. Descriptive statistics including frequencies, means and standard deviations were used to better characterize the patient populations in each group and patient follow-up. Independent sample *T* test and Chi-squared tests were used to compare rates across groups for numeric or ordinal variables, as appropriate. *P* values of less than 0.05 were considered statistically significant.

Results

A total of 308 cases of umbilical hernia repair were evaluated (Fig. 1). Seventy-three cases (23.7%) were excluded because the child underwent multiple procedures, and 31 cases (10%) were excluded because the child was documented to have a symptomatic umbilical hernia. Of symptomatic cases, eight umbilical hernias were incarcerated (2.6%). The other symptomatic cases include one of the following: umbilical drainage, skin excoriation or ulceration, or a history of a self-limiting episode of umbilical pain. The remaining 204 cases of asymptomatic, single-procedure, elective umbilical hernia repairs (Table 1) were included. Of these, 25 were performed on children < 2 years old (12.3%), 48 on children 2–4 years old (23.5%), and 131 on children > 4 years old (64.2%). There were no statistically significant differences in demographic data between the groups.

Pre-operative consultation records for children under 4 years old were evaluated for described indications for early repair. In children under 2 years old, the indication for surgery was described by the operating surgeon as a large defect in 92% of cases and parental preference in 16% of cases. For children 2–4 years old, the indication was a large defect in 14.6% of cases and parental preference in 20.8% of cases. The remaining cases (64.4%) had no specific indication noted. Operative notes demonstrated that average hernia size was inversely related to age ($p < 0.001$). The mean hernia defect size of children < 2 years was 2.41 ± 0.91 cm, compared to 1.29 ± 0.85 cm in children 2–4 years old, and 0.92 ± 0.91 cm in children > 4 years old.

A total of 25 children (12.3%) received their initial post-operative follow-up with a primary care provider, 128 children (62.7%) were assessed in surgery clinic in the first month postoperatively, and 51 (25.0%) received telephone follow-up from a pediatric surgery provider. The children were followed longitudinally by examining the most recent provider notes for evidence of recurrence or long-term complications. Our mean follow-up time was 4.48 ± 3.49 years. Anesthesia records,

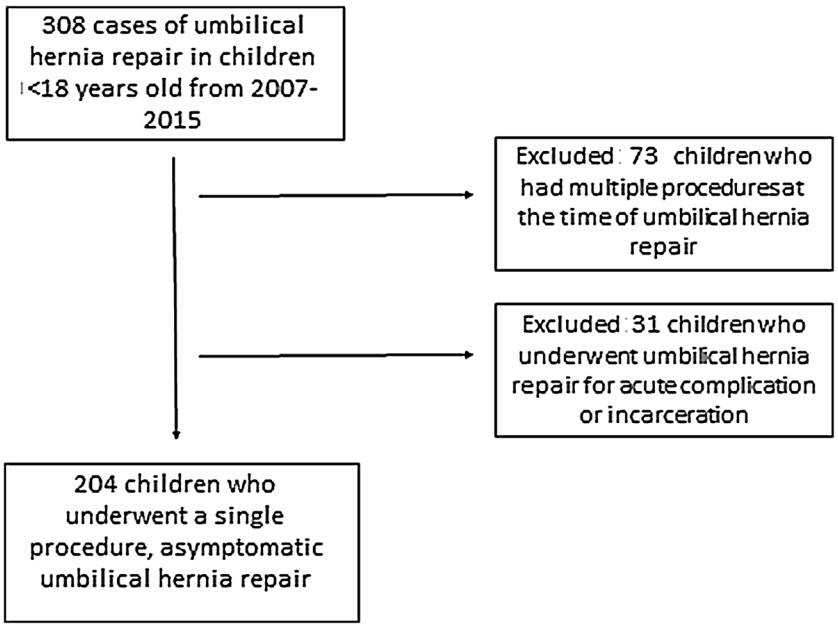

Fig. 1 Inclusion and exclusion of patients

Table 1 Patient demographics

	Children < 2 years old *N* = 25 (12.3%)	Children 2–4 years old *N* = 48 (23.5%)	Children > 4 years old *N* = 131 (64.2%)
Gender			
Male	12 (48%)	21 (43.8%)	73 (55.7%)
Female	13 (52%)	27 (56.3%)	58 (44.3%)
Patient race			
White	12 (48%)	31 (64.2%)	88 (67.2%)
Black	12 (48%)	11 (22.9%)	29 (22.1%)
Hispanic	0 (0%)	1 (2.1%)	5 (3.8%)
Other	1 (4%)	5 (10.5%)	9 (6.9%)
Medical comorbidities			
Any	6 (24%)	10 (20.8%)	59 (45%)
Respiratory	5 (20%)	4 (8.3%)	32 (24.4%)
Cardiovascular	1 (4%)	2 (4.2%)	8 (6.1%)
Gastrointestinal	3 (12%)	1 (2.1%)	13 (9.9%)
Neurological	0 (0%)	2 (4.2%)	7 (5.3%)

postoperative recovery room records and postoperative provider notes showed that complications were significantly less frequent in children > 4 years old (Table 2). Children < 2 years old had a complication rate of 12%, children 2–4 years old had a complication rate of 12.5%, and children > 4 years old had a complication rate of 3.1% ($p = 0.034$). Furthermore, the type of complications differed among age groups ($p = 0.031$). In children < 2 years old, two of three reported complications were either intraoperative or postoperative respiratory events including bronchospasm, apnea, and laryngospasm. The sole postoperative readmission occurred in an 18-month-old child within 36 h of the surgical procedure. In children 2–4 years old, local wound complications such as surgical site infection, seroma, hematoma, or dehiscence were most common, at 6% of patients and half of the reported complications, while two patients (4%) had respiratory complications and a single patient had a *Clostridium difficile* infection. In children > 4 years old, the wound complication rate was 2% (2 patients) and there was one case each of seroma and recurrence requiring reoperation.

Table 2 Complication rates by age

	Children < 2 years $N=25$	Children 2–4 years $N=48$	Children > 4 years $N=131$	p
Complication				
Yes	3 (12%)	6 (12.5%)	4 (3.1%)	0.034
Type of complication				
C. difficile	0	1 (2%)	0	0.031
Readmission	1 (4%)	0	0	
Recurrence	0	0	1 (1%)	
Respiratory	2 (8%)	2 (4%)	0	
Seroma	0	0	1 (1%)	
Wound complication	0	3 (6%)	2 (2%)	

Discussion

This study is the first to describe an age-dependent rate of complications for the repair of asymptomatic umbilical hernias in children, an extremely common procedure with wide practice variation. The data demonstrated a statistically significant increase in the rate of complications in children < 4 years old, with the severity of complications appearing to be inversely related to age.

For purposes of analysis, patients were divided into three groups based on age. In the first group (children < 2 years old), the literature indicates a high likelihood of spontaneous closure and consensus practice does not support elective repair [4]. In the second group (children 2–4 years old), there are some data suggesting that elective repair is safe; however, there is also evidence to suggest these hernias may still close spontaneously [4]. In the final group (children > 4 years old), the majority of the evidence supports elective repair; spontaneous closure, although possible, appears less likely [4]. The literature does not demonstrate significant increased risk of complications from unrepaired umbilical hernias in children under four, suggesting that watchful waiting is a safe practice [4, 7, 11, 20–23].

Our study captured short-term complications following surgery, but there has also been significant concern regarding the long-term neurocognitive risks of anesthesia in the very young. A recent editorial in the *New England Journal of Medicine* summarized the clinical implications of anesthetic neurotoxicity, suggesting parents and providers should carefully consider the risks of anesthetics on the developing brain in children under 3 year old [24]. Similarly, the Food and Drug Administration (FDA) has issued a statement urging providers to delay surgery when medically appropriate in children under three requiring prolonged general anesthesia or multiple anesthetics [25]. Although umbilical hernia repairs rarely require prolonged anesthesia, if an additional procedure is indicated within the first few years of life, an elective umbilical hernia repair may place the child at risk of receiving multiple anesthetics. Data supporting these recommendations come from several human meta-analyses and animal studies demonstrating learning disabilities, cognitive and language delays, long-term academic performance deficits, and behavioral problems in young children exposed to anesthetics, although these studies may be confounded by patient selection [16–18, 26–32]. In addition, the anesthesia literature has recently highlighted the consequences of intraoperative hypotension and brain hypoperfusion, demonstrating long-term sequelae, including encephalopathy and seizures in young children, particularly infants [33–36].

In our study of institutional data, the indication for 92% of umbilical hernia repairs in children < 2 years old and 14.6% of children 2–4 years old was a large hernia defect. Unfortunately, both in the literature [4] and our sample there is no pre-determined definition of a large hernia defect and it is based primarily on surgeon discretion. In fact, in our data, large defects ranged in size on operative reports from 1.3 to 5.0 cm with a mean of 2.4 cm. Although the literature demonstrates smaller defects are more likely to close spontaneously [12], several studies document the potential for larger hernia defects to close [8, 9, 37]. Additionally, there is no definitive evidence correlating large hernia size and complication rate, suggesting that watchful waiting is safe regardless of hernia size, so long as the patient remains asymptomatic [4, 10]. In fact, two large retrospective cohort studies have found smaller hernia defects (< 1.5 cm) were more prone to complications [7, 11]. In addition to hernia size, parental preference was cited as a reason for early operative repair. Although it is important to provide patient- and family-centered care, this illustrates the importance of patient and family education regarding the relative risks and benefits of surgery.

At this institution, the complication rate for children < 4 years old was significantly higher than children > 4 years old ($p=0.034$). In addition, the severity of complications appeared to be inversely associated with age. The rates of respiratory complications were highest in children under 2 years old, and no respiratory complications were documented in children over 4 years old. Although our

findings are limited by our small sample size (we noted only 13 postoperative complications in all groups), they are supported by the current literature. A study by Mamie et al. of 800 children undergoing elective procedures found the risk of an adverse respiratory event decreased by 8% with each increasing year of life [19]. Anesthesia for all operations at this institution is administered by pediatric anesthesiologists with extensive experience caring for children, which may not be the case in community hospitals. Studies have shown inexperience in anesthesia providers can be associated with increased incidence of laryngospasm [38]. The only readmission was noted in a child repaired under the age of 2 years old. Once again, this observation is supported by the literature. A 2017 study examined admission data from 258 academic centers and found admission service, patient age and length of stay were the most important predictors of 30-day readmission [39]. It is important to note that all the postoperative complications we identified were minor complications with none resulting in extended hospital stay or mortality. However, we are unable to predict what percentage of children would have had their defect close spontaneously if no intervention was performed, and some of these minor complications may have resulted from an unnecessary surgery.

The analysis of institutional postoperative complication data is limited by our small sample size and larger studies are needed to demonstrate reproducibility of these findings.

Conclusions

Our single-institution, retrospective study of complications from asymptomatic umbilical hernias suggests that children undergoing repair at young ages may be at increased risk for clinically meaningful post-operative complications. As umbilical hernias may resolve over time and can safely be monitored with watchful waiting, formal guidelines indicating the benefit of delaying repair until after the age of 4 years might prevent unnecessary surgical referrals, operations, and complications in young children.

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Compliance with ethical standards

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