

# Predictors of spontaneous resolution of umbilical hernia in children

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## ABSTRACT

**Objective** The aims were to describe the management of umbilical hernias, to define postoperative complications, and to identify the characteristics of patients that were more likely to have spontaneous resolution of their hernia.

**Methods** All patients referred for umbilical hernia at the Children's Hospital of Eastern Ontario from January 1990 to April 2017 were examined via retrospective chart review. Spontaneous resolution of umbilical hernia was examined using binary logistic regression.

**Results** We included 2621 patients presenting with an umbilical hernia. A total of 1587 (60.5%) patients underwent surgical repair at a median age of 3.6 years (IQR 2.3–5.4). Surgical complications consisted of infection (n=3), bleeding (n=3), hematoma (n=3), and anesthesia-related complications (n=3). For every one-unit increase in defect size, the odds of a spontaneous resolution of the hernia were 5% lower while controlling for prematurity and the presence of comorbidities [adjusted odds ratio (aOR)=0.95; 95% confidence interval (CI) 0.93 to 0.97]. Premature babies were 80% less likely to experience hernia resolution compared with non-premature babies (aOR=0.20; 95% CI 0.03 to 0.74).

**Conclusion** The odds of spontaneous resolution were lower for premature babies and were negatively correlated with defect size.

## INTRODUCTION

Pediatric umbilical hernias affect approximately 10%–30% of live births annually.<sup>1 2</sup> This rate decreases between 2% and 10% after 1 year, with nearly 90% umbilical hernias resolving spontaneously within the first few years of life.<sup>3</sup> Presently, expectant management, or watchful waiting, is the current medical guideline for monitoring umbilical hernias until children reach 4–5 years of age. Complications that may occur include incarceration and strangulation. The rate of these complications is quite low (0.16%–0.81%).<sup>3–5</sup> There is no consensus regarding appropriate timing of surgical repair or indications for surgery by any of the major pediatric associations (eg, Canadian Association of Pediatric Surgery, American Academy of Pediatrics, the American Pediatric Surgical Association or the

## Key messages

### What is already known about this subject?

- ▶ Pediatric umbilical hernias are common, affecting approximately 10%–30% of live births.
- ▶ There is minimal evidence on factors affecting the likelihood of spontaneous resolution in children.
- ▶ There is no consensus regarding appropriate timing of surgical repair for umbilical hernias in children.

### What are the new findings?

- ▶ Umbilical hernias are unlikely to become strangulated or incarcerated.
- ▶ The probability of spontaneous resolution is lower for premature babies.
- ▶ The probability of spontaneous resolution is negatively correlated with the defect size when adjusting for prematurity and other comorbidities.

### How might it impact on clinical practice in foreseeable future?

- ▶ Our findings help to identify characteristics of patients who are more likely to have spontaneous resolution of umbilical hernia.
- ▶ Factors such as prematurity and increasing defect size should continue to be considered during the management of children with umbilical hernia.
- ▶ As umbilical hernias are usually a benign condition with a very low complication rate, family physicians should encourage parents to monitor their child's condition until 4–5 years of age while being cognizant of any potential complications.

American College of Surgeons).<sup>3</sup> A better understanding of the natural history of uncomplicated umbilical hernias, management and treatment outcomes is required. Additionally, there is minimal evidence on risk factors affecting the likelihood of spontaneous resolution in children.<sup>3 6</sup> An in-depth analysis of various parameters influencing clinical outcomes, such as spontaneous resolution, has not been elucidated extensively,<sup>3 4 7 8</sup> or at our institution. Therefore, the aim of this study was to conduct a retrospective chart review on the surgical outcomes of all patients with umbilical hernia treated at the Children's Hospital of Eastern Ontario (CHEO), Canada. The objective was to describe factors of



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spontaneous resolution, clinical outcomes, such as rate of recurrence, and complications.

## METHODS

After obtaining approval from our institution's research ethics board (REB), we performed a retrospective chart review in EPIC (Electronic Health Records). Hyperspace of all patients referred for umbilical hernia to CHEO between January 1990 and April 2017.

Study participants were identified from patient records, based on the diagnostic code for umbilical hernia obtained from the CHEO Clinical Research Unit. We included all children under 18 years of age who were referred to CHEO for umbilical hernia repair during the designated capture period, which explained how our study sample size was obtained. Umbilical hernia repair refers to the procedure whereby a surgeon makes a small incision at the base of a patient's belly button and pushes the loop of bowel back into the abdominal wall. Exclusion criteria were: (1) young adults >18 years of age and (2) children with umbilical hernia who were discovered as an incidental finding while undergoing surgical procedure for another condition. Medical records for all patients identified were reviewed and abstracted. Data were compiled into The Research Electronic Data Capture Database (REDCap).<sup>9</sup>

Variables extracted from medical records included date of birth, gender, age at first referral, size of defect (mm), comorbidities (any cardiac, genetic, neurological, and nephrological disorders), dates of resolution (day, month, year), incarceration, and/or strangulation, date of surgery, and any perioperative complications. The main outcome of interest was spontaneous resolution of hernia. One potential confounder is prematurity, defined as gestational age less than 37 weeks. To eliminate the potential for confounding, we excluded patients with an incidental finding of umbilical hernia from our study.

Descriptive statistics were performed for age, timing of repair, and complications. Binary logistic regression was performed to identify predictors of preoperative complications (incarceration/strangulation) and odds of spontaneous resolution of umbilical hernia, in an attempt to identify a cohort that would benefit from earlier surgical repair. A subgroup analysis was performed exclusively on patients with complications, due to the presence of effect modification between umbilical hernia and resolution of the hernia.

## RESULTS

A total of 2621 patients with umbilical hernias were eligible and reviewed for inclusion in this study. **Table 1** provides an overview of patient characteristics. Half (51%) were women. Mean age at first referral was 2.9±3.0 years. Of the total sample size, 970 children had pre-existing comorbidities, including cardiac, genetic, neurological, and nephrological disorders. Of the patients

**Table 1** Characteristics of study population (n=2621)

Characteristic	Value
Gender (male)*	1280 (48.8)
Age at first referral (y)†	2.9±3.0
Comorbidity*	970 (37.0)
Incarceration*	31 (1.2)
Age at incarceration (y)‡	3.7 (1.7 to 7.0)
Strangulation*	2 (0.1)
Age at strangulation (y)‡	11.8 (10.8 to 12.9)
Resolution of hernia*	1031 (39.4)
Age at resolution (y)‡	2.9 (1.4 to 4.3)
Surgery*	1587 (60.5)
Age at surgery (y)‡	3.6 (2.3 to 5.4)
Perioperative complications*	
Infection	3 (0.1)
Bleeding	3 (0.1)
Anesthesia-related	3 (0.1)
Other	3 (0.1)
Size of defect (mm)‡	7.0 (5.0 to 10.0)
Recurrence*	20 (1.3)

\*Data were presented as n (%).

†Data were presented as mean±SD.

‡Data were presented as median (IQR).

IQR, interquartile range; SD, standard deviation.

encountered, 39.5% experienced spontaneous closure. The remainder went on to have a surgical repair.

The median size of defect was 7mm. Perioperative complications (eg, infection, bleeding, anesthesia-related complications) occurred in 12 cases. There were 20 (0.75%) instances of recurrence, with a median age of 4.2 years at recurrence. There were 37 children over the age of 10 years who had an umbilical hernia while undergoing surgery for unrelated conditions, which was an incidental finding and was thus removed from the analysis to eliminate any potential for bias towards spontaneous resolution of hernia. There were missing data for defect size in 1257 participants, which had to be excluded in the binary logistic regression analysis.

## Complications

A total of 33 patients experienced incarceration and two experienced strangulation in this group (**table 2**). Age at referral for this subgroup was slightly higher, at a median of 3.8 years. There were no operative complications; however, the size of defect was greater (median 10 mm). Recurrence occurred in one case.

## Characteristics of patients at high risk of complications

The number of spontaneous resolution of umbilical hernia events totaled 1031 (**table 3**). Premature babies were found to be 80% less likely to have spontaneous resolution of hernia compared with non-premature

**Table 2** Characteristics of patients with complication (n=33)

Characteristic	Value
Gender (male)*	17 (51.5)
Age at first referral (y)†	4.5±4.9
Comorbidity*	14 (42.4)
Incarceration*	31 (93.9)
Age at incarceration (y)‡	3.7 (1.7 to 7.0)
Strangulation*	2 (6.1)
Age at strangulation (y)‡	11.8 (10.8 to 12.9)
Surgery*	32 (97.0)
Age at surgery (y)‡	3.8 (2.0 to 8.1)
Perioperative complications*	0 (0.0)
Size of defect (mm)‡	10.0 (5.0 to 10.0)
Recurrence*	1 (3.2)

\*Data were presented as n (%).

†Data were presented as mean±SD.

‡Data were presented as median (IQR).

IQR, interquartile range; SD, standard deviation.

babies [adjusted odds ratio (aOR)=0.20; 95% confidence interval (CI) 0.03 to 0.74] (table 3). Additionally, for every millimeter increase in defect size, the odds of spontaneous resolution was 5% lower while controlling for gender, prematurity, and presence of comorbidities (aOR 0.95; 95% CI 0.93 to 0.97).

## DISCUSSION

This study sought to examine the clinical outcomes and complications of umbilical hernias as well as to identify factors for spontaneous resolution among children. In our study population, nearly half experienced spontaneous resolution of hernia by 4–5 years of age. The low rate of strangulation and incarceration suggests that if left untreated, umbilical hernia may resolve by itself. The

low rate of perioperative complications (n=33; 1.26%) and recurrence (n=20; 0.76%) further suggests that repair is a safe procedure, even after 4–5 years of age. These findings are consistent with a recent American study, which stated that the rate of preoperative complications in umbilical hernia (eg, incarceration, strangulation, and evisceration) were low, occurring in approximately 1 in 1500 hernias. Overall, our study findings suggest that patients with asymptomatic umbilical hernia can be followed up safely by their family physician until 4–5 years of age, at least at our institution. Caution should be exercised when generalizing our results to other institutions across Canada.

Our study demonstrated that for every 1 mm increase in defect size, the odds of spontaneous resolution of umbilical hernia decreased by 5%. Despite 89.1% of hernias closing spontaneously at age 6, a study conducted by Walker and colleagues found that larger hernias were also less likely to close; in fact, 0% (0/21) with a defect >1.5 cm were closed by 6 years of age.<sup>10</sup> In contrast, hernia prevalence may decrease with increasing age, indicating that the majority of large hernias may close by ages 3–4 without the need for surgery.<sup>11</sup> Although not statistically significant in our study, prior literature attests that comorbidities, such as childhood obesity, may impact the likelihood of spontaneous closure.<sup>3</sup> Interestingly, in our study, 40% of men and 38.7% of women had spontaneous resolution of umbilical hernia; however, when examining results of the logistic regression, this difference based on gender is not statistically significant. In other words, at least in our sample, there is no difference in frequency of spontaneous resolution of umbilical hernia among men versus women.

Premature babies were 80% less likely to have a spontaneous resolution compared with non-premature babies in our study. This may be due to incomplete closure of the fascia of the umbilical ring, through which abdominal contents may protrude. The umbilical ring undergoes

**Table 3** Logistic regression-determining the odds of spontaneous resolution of hernia

Variable	Resolution of hernia n (%)	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Gender			0.50		0.56
Male	512/1280 (40.0)	1.0		1.0	
Female	519/1341 (38.7)	0.95 (0.81 to 1.11)		1.07 (0.86 to 1.33)	
Premature			0.40		0.01
No	1016/2576 (39.4)	1.0		1.0	
Yes	15/45 (33.3)	0.77 (0.40 to 1.41)		0.20 (0.03 to 0.74)	
Defect size		0.95 (0.93 to 0.97)	<0.001	0.95 (0.93 to 0.97)	<0.001
Comorbidity			0.16		0.42
No	667/1651 (40.4)	1.0		1.0	
Yes	364/970 (37.5)	0.89 (0.76 to 1.05)		0.90 (0.71 to 1.16)	

The total sample size was 2621 and multivariable logistic regression was applied.

P<0.05 considered as significant.

CI, confidential interval; OR, odd ratio.

spontaneous closure through the growth of rectus muscles and fusion of the fascial layers after separation of umbilical cord. The failure or delay in process can lead to the umbilical hernia formation.<sup>4</sup>

As supported by Halleran and colleagues, we surmised that unplanned hospital visits among families of young children (<4 years) could be diverted if patients with asymptomatic umbilical hernia were followed up by their family physicians conservatively.<sup>7</sup> This might decrease the waiting time or eliminate the need for pediatric surgeon consultation in-hospitals because active patient monitoring by family physicians via conservative treatment strategies could potentially reduce unintended, adverse clinical outcomes.

The main limitation of this study was the retrospective design, which does not permit data collection on additional variables that could influence defect size and rates of recurrence or postoperative complications. Moreover, there were considerable data missing on defect size. As such, we were unable to provide a recommendation for a clinical cut-off for defect size in non-resolution cases. This large and robust sample is only reflective of one institution's experience, in children aged 0–18 years and thus cannot be generalized to children in other institutions. Overall, our findings contribute to a field that has received minimal empirical attention.

Strengths of this study include identifying factors for spontaneous resolution of umbilical hernia. This information can help family physicians at CHEO when deciding which patients will have higher chances of spontaneous resolution and thus, which patients will benefit from an earlier surgical intervention or if it is recommended to be followed conservatively. Another advantage is the thorough collection of data regarding the progress of patients from the time of first admission until discharge, validated by the study team. The data collected therefore provide an accurate representation of clinical indicators and management of umbilical hernia at one Canadian Hospital.

Results from this study demonstrate that pediatric umbilical hernias are unlikely to become strangulated or incarcerated. The probability of spontaneous resolution of umbilical hernia decreases with an increase in defect size while controlling for prematurity and other comorbidities. On the other hand, probability of non-resolution increases with prematurity. In light of these findings, factors such as prematurity and increasing defect size should continue to be considered during the management of children with umbilical hernia in Ontario. Because umbilical hernias are usually a benign condition with a very low complication rate, family physicians should encourage parents to monitor their child's condition until 4–5 years of age while being cognizant of any potential complications. Overall, conservative management is justifiable and appropriate during pediatric monitoring of asymptomatic umbilical hernia.

In conclusion, we aimed to characterize the probability of spontaneous resolution for umbilical hernia in our Eastern Ontario cohort. Overall, our study determined that the odds of spontaneous resolution were lower for premature babies and were negatively correlated with defect size. As such, continued monitoring of defect size and prematurity is warranted during umbilical hernia management of children in Ontario.

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**Contributors** MK contributed to investigation, data curation and writing—original draft. VG was responsible for data curation, project administration, resources, supervision, visualization and writing—review and editing. IO carried out data curation, project administration, resources, supervision, validation, visualization and writing—review and editing. AW performed data curation, project administration, resources and supervision. AN was involved in conceptualization, methodology, supervision, validation and writing—review and editing.

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