Scientific Open Access Journals
SOAJ

Surgery: Open Access

Case Report Open Access

Ward Reduction – Rewarding Action?

Laura Zaccaria, Ulrike Subotic, Luca Mazzone, Martin Meuli*, Ueli Moehrlen*

Department of Pediatric Surgery, University Children's Hospital Zurich, Steinwiesstrasse 75, CH-8032 Zurich, Switzerland

***Corresponding author: Ueli Moehrlen,** Email: ueli.moehrlen@kispi.uzh.ch
*both authors share last authorship

Received: 21 January 2018; **Accepted:** 11 April 2018; **Published:** 18 April 2018

Abstract

Purpose: In the year 1998, the so-called ward reduction was introduced by Bianchi and Dickson. Even though both concept and preliminary results were appealing, this approach has not found general acceptance, and, correspondingly, only few reports exist. Here, we report our experience with this treatment modality.

Methods: All babies with gastroschisis born between 2009 and 2014 were retrospectively analyzed. The main variables looked at included gestational age, birth weight, APGAR-score, intubation time, days of parenteral nutrition, age at first enteral feed, days on neonatal intensive care unit, length of hospital stay, and complications. In order to guarantee the optimal treatment for gastroschisis (ward reduction vs. spring-loaded silo), we created an own algorithm (Figure 1).

Results: 24 patients with gastroschisis were included in the study. Ward reduction was initially considered in all patients, but only performed in 11. One of these babies died at the age of 75 days because of complications related to short bowel syndrome. The other 10 babies had an uneventful post-intervention course and could be discharged home on regular oral feeding within 21-75 days (median=40 days). 13 patients were classified as 'complicated'. Therefore, a spring-loaded silo was installed in 10 patients (edematous bowel n=3, fetal peritonitis n=1, intestinal small bowel atresia n=2, hypoplasia of the colon n=1, Meckel's diverticulum n=1, hypoplastic abdominal cavity n=1, and persistent omphaloenteric duct n=1). Three patients (colon atresia and jejunal stenosis n=1, suspicion of intestinal atresia n=1, and marked fetal peritonitis n=1) were treated by primary abdominal wall closure. In the silo group, one baby died because of non gastroschisis related conditions (trisomy 13 with severe cardiac defect). Another baby with venous congestion of the small intestine mandated laparotomy to widen the abdominal wall defect. The remaining 8 babies of the silo-group had mainly an uneventful postoperative course. In general, these babies were discharged home on regular oral feeding within 25-126 days (median=49.5 days).

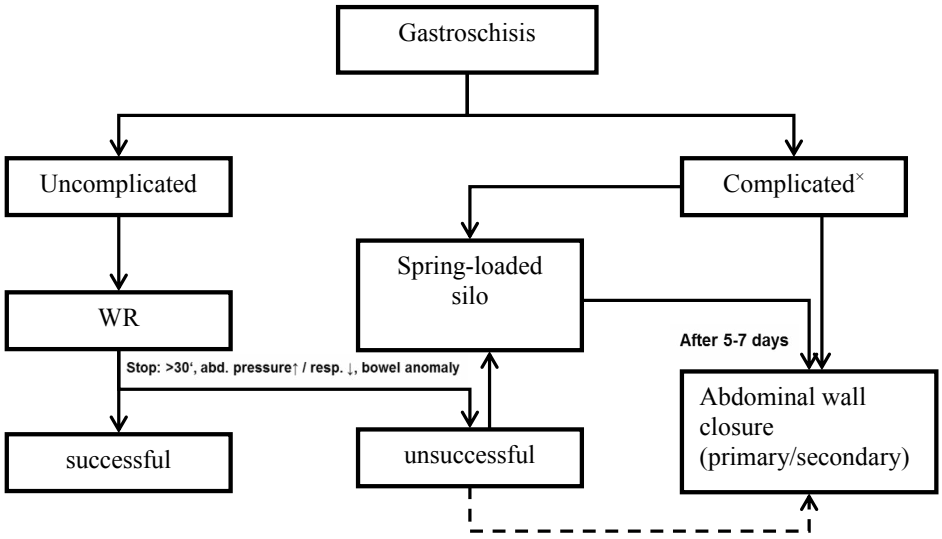
Conclusion: Ward reduction is an attractive, minimally-invasive therapy for select babies born with uncomplicated gastroschisis. It appears to be safe, effective, easy to perform, and it spares the newborn baby one or two formal operations.

Keywords: Gastroschisis; Ward reduction; Spring-loaded silo

Introduction

Gastroschisis (GS) is a full-thickness open and non-covered abdominal wall defect, characterized by protrusion of intestines and, occasionally, other abdominal organs [1]. Worldwide the incidence of GS ranges between 1 and 5 per 10,000 births and it seems to have increased over the past 2 decades [2,3].

Since Watkins first reported a successful primary closure of a small abdominal wall defect in 1943 [4], the surgical closure has become the standard of care for GS. When the herniated bowel is significantly thickened and/or dilated, or when the abdomen is hypoplastic, a primary closure may lead to an increased intra-abdominal pressure. In these cases, a step by step reduction is recommended. Schuster described in 1967 [5] a staged procedure for the repair of omphaloceles, using a prosthetic silo to reduce gradually the eviscerated bowel. This technique was also adopted for GS and is still recommended today. Fischer in 1995 reported for the first time the use of a SILASTIC spring-loaded silo, which can easily be placed at the bedside with no need for general anesthesia [6]. Three years later Bianchi and Dickson introduced the so-called ward reduction (WR). They reported on 14 neonates with GS treated with gut reduction without general anesthesia in the ward. After bowel reduction, the abdominal opening was closed by capping of the umbilical cord and suturing the cord stump to the rectus sheath [7]. From the reported 14 cases, 12 survived. Although these results were quite encouraging, there are astonishingly few reports looking at this innovative approach [7-13]. Based on the available literature,



×Complicated means: edematous bowel, intestinal malformation, bowel necrosis, cardiovascular instability.

Figure 1: Algorithm for GS management at the University Children's Hospital Zurich.

we hypothesized that WR could in fact represent a step forward in the treatment of GS and we adopted this technique in 2009. Using the selection criteria published by Bianchi [8] and Kimble [9], we created an algorithm for the management of GS in our institution (Figure 1).

The goal of this paper is to analyze the outcome of babies born with GS and treated along the described algorithm.

Material and Methods

Over a 5-year period from 2009 through 2014, all charts of neonates with GS treated at the University Children's Hospital Zurich were retrospectively reviewed. The following parameters were analyzed: mode of GS treatment, gestational age (GA), birth weight, APGAR-score, intubation time, days of parenteral nutrition (TPN), age at first enteral feed, days on neonatal intensive care unit (NICU), length of hospital stay, and complications (Table 1).

WR was considered as a first-line management for all patients. However, true candidates for WR were selected in a standardized way using the above-mentioned algorithm (Figure 1). If the abdominal cavity is hypoplastic with consecutively increased intra-abdominal pressure during bowel reduction and/or respiratory failure, or if reduction lasts too long, WR is stopped and a spring-loaded silo is installed. Furthermore, neonates with markedly edematous bowel, intestinal malformations, bowel necrosis, or any sort of postnatal cardiorespiratory compromise are graded as 'complicated'. These neonates are excluded from attempting a WR and a spring-loaded silo is applied right away.

WR is attempted either directly in the delivery room or in the NICU. After cardiovascular stabilization, the neonate is evaluated for WR. A nasogastric tube is positioned and an intravenous line is placed. An appropriate analgosedation with Ketamine and Nalbuphine as well as antibiotics (triple therapy with Metronidazole 10mg/kg, Sintetica; Gentamicin 2.5mg/kg, Ratiopharm and Amoxicillin 25mg/kg, GlaxoSmithKline AG) are administered. Initially, colonic irrigation with 20-30ml warm saline solution (NaCl 0.9%, B. Braun) is performed to evacuate meconium. Then, the eviscerated bowel is gently reduced into the abdominal cavity. Before the abdominal wall defect is closed, local anesthesia (Bupivacaine hydrochloride 0.5%, AstraZeneca) is applied. Then a purse-string suture (PDS II 2-0, SH needle, Ethicon) incorporating peritoneum, fascia and muscle, is placed to close the abdominal opening. At the end, the skin is closed and covered by the umbilical cord.

Results

During the study period, 23 children with GS were born by cesarean section at a median gestational age of 36.5 weeks (range 33.2-38.5). In one baby, the diagnosis of GS was only made postnatally after vaginal delivery at 35 weeks of gestation. According to our algorithm, 11 of 24 patients (46%) qualified for WR. The other 13 neonates (54%) were classified as 'complicated' because of the following conditions: edematous bowel (n=3, 13%), severe fetal peritonitis (n=2, 8%), hypoplastic abdominal cavity in a small for gestational age baby (SGA, n=1, 4%), Meckel's diverticulum (n=1, 4%), persistent omphaloenteric duct (n=1, 4%), intestinal atresia (n=3, 13%), hypoplastic colon (n=1, 4%), and suspicion of small bowel atresia (n=1, 4%). In these patients, a spring-loaded silo was installed in 10 (42%) neonates, and in 3 (13%) neonates, a primary abdominal wall closure under general anesthesia was performed.

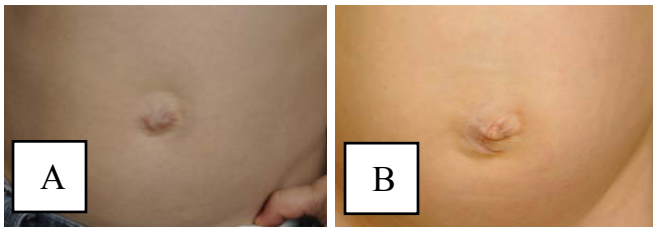
The key data of all three groups are listed in Table 1.

The follow-up period ranged from 1 to 5 years for the WR and silo-group, and from 1 to 3 years for the group with a primary abdominal wall closure.

In short, the essential data are the following: All newborns evaluated as uncomplicated GS underwent WR successfully. After WR, all children showed an aesthetically well appearing umbilicus (Figure 2). No umbilical hernias were detected in this group. One newborn (4%) developed an abdominal compartment syndrome within 24 hours after WR. Due to diffuse intestinal necrosis, multiple bowel resections and a Schuster plasty were performed. This resulted in a severe short bowel syndrome and death at 75 days of age. One newborn (4%) required further surgery to correct a colonic stenosis at the age of 1 month. Two

Table 1: Comparison of the main values (median and range) in patients with GS treated at the University Children's Hospital Zurich between 2009 and 2014.

	WR (n=11)	**Spring-loaded silo (n=10)**	**Primary abdominal wall closure (n=3)**
Sex	F=2; M=9	F=3; M=7	F=2; M=1
GA (weeks)	37 (34.5-38.5)	36.4 (33.6-38.5)	35.5 (33.2-37.2)
APGAR	6/8/8 (1-8)/(3-9)/(1-10)	7/8/8 (2-8)/(4-9)/(4-9)	7/9/9 (5-8)/(8-9)/(9)
Birth weight (gram)	2580 (2130-3240)	2340 (1600-3500)	2620 (2040-2930)
Days on NICU (days)	3.5 (1-13)	9.5 (4-17)	7 (3-15)
Intubation (number of patients)	3/11	10/10	3/3
Intubation-time (hours)	21.8 (0-124)	73 (20-240)	67.5 (10-145)
Need for TPN (days)	32 (17-74)	41.5 (21-119)	67.5 (29-144)
Age at first enteral feed (days)	18 (2-43)	28 (8-92)	15 (14-17)
Age at discharge (days)	40 (21-75)	49.5 (25-126)	82 (37-171)
Complications (related to the initial therapy)	1x death because of severe short bowel syndrome 1x intestinal obstruction because of subtotal stenosis of the ileum	1x abdominal compartment syndrome; 1x silo dislocation twice; 1x perfusion problems due to narrow abdominal defect; 1x chronic skin infection	1x severe adhesions, abdominal compartment syndrome, NEC
Complications (in the follow-up, unrelated to initial therapy)	1x colonic stenosis; 1x intestinal obstruction because of thickened meconium; 1x iatrogenic stomach perforation; 2x catheter sepsis twice	1x death (trisomy 13 and cardiac malformation); 1x transient short bowel syndrome because of NEC; 4x catheter sepsis (3x twice)	1x obstruction of anastomosis after ostomy closure, 3x catheter sepsis



After WR, all children showed an aesthetically well appearing umbilicus.
A and B: two boys at the age of 2 years.

Figure 2: Pictures of the umbilicus after WR

babies (8%) developed an intestinal obstruction at day 17 and 33 of life and therefore needed a revision.

In one case, the bowel obstruction was caused by thickened meconium. Therefore the bowel obstruction was neither related to an anatomical malformation nor to the WR.

In the other case the bowel obstruction was caused by a 3cm long, subtotal stenosis of the ileum. One newborn (4%) needed surgery due to an iatrogenic gastric perforation caused by a malpositioned nasogastric tube at 4 days of life.

In the spring-loaded silo group (n=10), one neonate (4%) died at 3½ months because of a non GS related problem (trisomy 13 with severe cardiac defect). There were no umbilical hernias in this group as well. In a patient (4%) with colonic atresia and jejunal stenosis, surgical correction and abdominal closure occurred 4 days after silo placement. One patient (4%) showed a long-segment hypoplasia of the ascending colon. Therefore, approximately 20cm of colon including the ileocoecal valve and the appendix were resected before silo placement. One neonate (4%) developed an abdominal compartment syndrome one day after abdominal wall closure due to sepsis at the age of 10 days. This child was treated by a Schuster plasty and then showed an uneventful course (gradual reduction and definitive fascial closure using a Permacol®-Patch, Covidien after 9 days). Another patient (4%) showed twice a silo-dislocation (day 6 and 12 of life). In the postoperative course, one neonate (4%) developed a transient short bowel syndrome due to a necrotizing enterocolitis (NEC) at 2 months of life, which was treated surgically (several revision laparotomies). To date, this child eats normally and thrives well. A few hours after silo application, one neonate (4%) showed perfusion problems of the eviscerated bowel and therefore, the silo was removed and a Schuster plasty applied. In the further course, this patient developed an intestinal obstruction requiring a reoperation with an uneventful course. One patient (4%) with a secondary abdominal wall closure (Permacol®-Patch, Covidien) had several wound revisions due to infection.

Three patients (13%) were treated with a primary abdominal wall closure in the operating room under general anesthesia. One neonate (4%) had an atresia of the ascending colon and a stenosis of the jejunum; both pathologies were treated surgically at the time of primary abdominal wall closure. At the age of 3 months the child demonstrated acute intestinal obstruction, requiring bowel resection. In another neonate (4%), WR was abandoned due to suspicion of intestinal obstruction not confirmed in the operating room. The third neonate (4%) showed a marked fetal peritonitis with no other intestinal complications.

Discussion

After the first description of WR by Bianchi and Dickson in 1998 [7], only a few studies were published concerning this innovative approach [7-13]. A meticulous search in PubMed regarding WR yielded only 8 English reports including 2 reports from Bianchi et al. [7,8] and 3 reports from Kimble et al. [9-11]. 2 articles from other authors reported unsatisfactory results after WR [12,13].

WR has established itself as an attractive therapy option in our hospital because it is easy to perform without requiring a formal general anesthesia. In a comparative analysis between GS reduction with and without general anesthesia, Cauchi et al. [14] could demonstrate, that both therapy modality have similar outcomes in terms of quality of bowel, start of enteral feeds, hospital stay and morbidity. These data are in line with our findings.

To simplify the process of GS treatment and especially to correctly identify candidates suitable for WR, we created an own algorithm (Figure 1).

This paper is one of the very few reports on management and short term follow-up of newborns with GS who were treated primarily with WR or if not applicable with a spring loaded silo or direct abdominal closure.

Although the surgical strategies to treat GS have evolved over time, the principles of the management remained the same: first, safe reduction of the eviscerated organs and second, closure of the abdominal wall defect with an acceptable cosmetic appearance of the reconstructed umbilicus.

The current management of GS is, shortly summarized, a primary or staged reduction. Primary abdominal wall closure in the operating room is the standard initial surgical approach, whereas staged reduction is frequently used as a rescue strategy when thickened and edematous bowel caused by fetal peritonitis is present, or when there is a hypoplastic abdomen. In the latter cases, primary reduction will lead to high intra-abdominal pressure followed by an abdominal compartment syndrome [15,16]. Since the introduction of preformed spring-loaded silos [6], staged reduction can be performed without general anesthesia, analogous to WR. Doubtlessly, the advantages using a spring-loaded silo include a simple placement without need for general anesthesia during the first day of life, the chance of seeing constantly the bowel, and to perform a staged reduction in an individually timely manner. Thereby, the problems of significantly increased abdominal pressure can be avoided. These benefits are also underscored in most papers, in which the traditional primary closure and the use of a spring-loaded silo are compared [17-19]. Also, our data further support the already existing evidence that newborns with complicated GS can be successfully managed with staged reduction using a spring-loaded silo followed by formal surgical closure [20].

All three groups (WR, silo, primary closure) show similar complications (Table 1): In the WR-group, one child died at the age of 75 days of life because of the complications of a severe short bowel syndrome, in each group we found several catheter-associated sepsis complications, one child from the silo and one from the primary closure group developed an abdominal compartment syndrome and another child from the primary closure group developed NEC requiring medical treatment. Regardless of our small number of patients, we were able to show that WR seems at least as safe as silo application in uncomplicated GS. In complicated cases, where WR is not feasible, silo application is the rescue strategy of choice. Of course, a primary abdominal wall closure may be an alternative option, too. This decision of treatment was finally made by the senior attending surgeon on call.

An important sequel in children with GS is the long-term intolerance of enteral feeding due to severe gastrointestinal dysmotility [21,22]. In these children, enteral nutrition can only be advanced very slowly and must eventually be supplemented by parenteral nutrition. In addition, there is a 5-10% long-term risk of adhesion-associated obstructions in former series [2,23]. In the WR-group two neonates were re-operated because of an intestinal obstruction before the age of 1 month. Generally, we did not encounter long-term obstructions in any of the three groups. The most significant problems we saw were the death of one neonate at the age of 75 days in the WR-group, due to a severe short bowel syndrome and in the silo-group, one case of transient short bowel syndrome that was due to NEC and several revision laparotomies.

The disadvantage of an immediate abdominal closure for newborns with gastroschisis is the subsequent increase of intra-abdominal pressure after bowel reduction. All methods besides staged procedures adhere to this rare, but severe complication [15,16,24,25]. Therefore, a close surveillance of the newborns after WR is necessary. If any signs of increased abdominal pressure raise after WR, secondarily a silo has to be placed for a staged bowel reduction.

Compared to Bianchi and Dickson [7] there are two important differences in the implementation of WR. First, we perform WR under analgosedation, whereas they do not require analgesia or sedation. And second, we perform WR immediately after birth and cardiovascular stabilization of the neonate, whereas they perform WR on average 4 hours (range 3.5-11 hours) after birth. In their cases delaying gut reduction lead to more stable cardiovascular, respiratory and renal parameters. In our cases, we did not encounter any cardiovascular, respiratory or renal problems related to early gut reduction.

There are limitations to our study. The main limitation is inherent in an observational outcome study, but this study is strengthened by the consistency of a single-institution experience with an own algorithm for treatment for GS. Another important limitation is the fact, that both groups (WR versus silo) have different base-line conditions, and therefore cannot be compared. According to our algorithm (Figure 1) WR was performed in healthy neonates without intestinal problems and a spring-loaded silo was applied in complicated cases, where WR was not feasible.

Although the results are encouraging, a prospective study will probably address the true safety and efficacy of the WR.

Conclusion

Our data indicate that WR can be an effective treatment for newborns with uncomplicated GS. This technique appears to be safe, easy to perform, and it spares the newborn one or two formal operations. Nevertheless it should only be done in patients that meets certain selection criteria. Additionally, a high suspicion for compartment syndrome must kept in mind during the first days following abdominal wall closure.

References

1. Suver D, Lee SL, Sherkherdimian S, Kim SS. Left-sided gastroschisis: higher incidence of extraintestinal congenital anomalies. Am J Surg. 2008; 195:663-666.
2. Ledbetter DJ. Congenital Abdominal Wall Defects and Reconstruction in Pediatric Surgery. Surg Clin N Am. 2012; 92:713-727.
3. Fillingham A, Rankin J. Prevalence, prenatal diagnosis and survival of gastroschisis. Prenat Diagn. 2008; 28:1232-1237.
4. Watkins DE. Gastroschisis. Va Med Mon. 1943; 70.
5. Schuster SR. A new method for the staged repair of large omphaloceles. Surg Gynecol Obstet. 1967; 125:837-850.
6. Fischer JD, Chun K, Moores DC, Gibbs A. Gastroschisis: a simple technique for staged silo closure. J Pediatr Surg. 1995; 30:1169-1171.
7. Bianchi A, Dickson AP. Elective Delayed Reduction and No Anesthesia: 'Minimal Intervention Management' for Gastroschisis. J Pediatr Surg. 1998; 33:1338-1340.
8. Bianchi A, Dickson AP, Alizai NK. Elective Delayed Midgut Reduction- No Anesthesia for Gastroschisis: Selection and Conversion Criteria. J Pediatr Surg. 2002; 37:1334-1336.
9. Kimble RM, Singh SJ, Bourke C, Cass DT. Gastroschisis Reduction under Analgesia in the Neonatal Unit. J Pediatr Surg. 2001; 36:1672-1674.
10. Davies MW, Kimble RM, Cartwright DW. Gastroschisis: ward reduction compared with traditional reduction under general anesthesia. J Pediatr Surg. 2005; 40:523-527.
11. Davies MW, Kimble RM, Woodgate PG. Ward reduction without general anaesthesia versus reduction and repair under general anaesthesia for gastroschisis in newborn infants (Cochrane Review). The Cochrane Library. 2010; 4.
12. Dolgin SE, Midulla P, Shlasko E. Unsatisfactory Experience with 'Minimal Intervention Management' for Gastroschisis. J Pediatr Surg. 2000; 35: 1437-1439.
13. Rao SC, Pirie S, Minutillo C, Gollow I, Dickinson JE, Jacoby P. Ward reduction of gastroschisis in a single stage without general anaesthesia may increase the risk of short-term morbidities: Results of a retrospective audit. Journal of Paediatrics and Child Health. 2009; 45:384-388.
14. Cauchi J, Parikh DH, Samuel M, Gornall P. Does gastroschisis reduction require general anesthesia? A comparative analysis. J Pediatr Surg. 2006; 41:1294-12297.
15. Olesevich M, Alexander F, Mohammad K, Cotman K. Gastroschisis revisited: role of intraoperative measurement of abdominal pressure. J Pediatr Surg. 2005; 40:789-792.
16. McGuigan RM1, Mullenix PS, Vegunta R, Pearl RH, Sawin R, Azarow KS. Splanchnic perfusion pressure: a better predictor of safe primary closure than intraabdominal pressure in neonatal gastroschisis. J Pediatr Surg. 2006; 41:901-904.
17. Pastor AC, Phillips JD, Fenton SJ, Meyers RL, Lamm AW, Raval MV, et al. Routine use of SILASTIC spring-loaded silo for infants with gastroschisis: a multicenter randomized controlled trial. J Pediatr Surg. 2008; 43:1807-1812.
18. Schlatter M, Norris K, Uitvlugt N, DeCou J, Connors R. Improved Outcomes in the Treatment of Gastroschisis Using a Preformed Silo and Delayed Repair Approach. J Pediatr Surg. 2003; 38:459-464.
19. Lansdale N, Hill R, Gull-Zamir S, Drewett M, Parkinson E, Davenport M, et al. Staged reduction of gastroschisis using preformed silos: practicalities and problems. J Pediatr Surg. 2009; 44:2126-2129.
20. Kidd NJ, Jackson RJ, Smith SD, Wagner CW. Evolution of Staged Versus Primary Closure of Gastroschisis. Ann Surg. 2003; 237:759-765.
21. Maramreddy H, Fisher J, Slim M, LaGamma EF, Parvez B. Delivery of gastroschisis patients before 37 weeks of gestation is associated with increased morbidities. J Pediatr Surg. 2009; 44:1360-1366.
22. Erdogan D, Azili MN, Cavusoglu YH et al. 11-Year Experience with Gastroschisis: Factors Affecting Mortality and Morbidity. Iran J Pediatr. 2012; 22:339-343.
23. Van Eijck FC, Wijnen RM, Van Goor H. The incidence and morbidity of adhesions after treatment of neonates with gastroschisis and omphalocele: a 30-year review. J Pediatr Surg. 2008; 43:479-483.
24. Lacey SR, Carris LA, Beyer 3rd AJ, Azizkhan RG. Bladder pressure monitoring significantly enhances care of infants with abdominal wall defects: a prospective clinical study. J Pediatr Surg. 1993; 28:1370-1374.
25. Yaster M, Scherer TL, Stone MM, Maxwell LG, Schleien CL, Wetzel RC, et al. Prediction of successful primary closure of congenital abdominal wall defects using intraoperative measurements. J Pediatr Surg. 1989; 24:1217-1220.