



Staged Closure of Gastroschisis using Alexis Wound Retractor and Protector

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Abstract

Background: Gastroschisis is the most common congenital anterior abdominal wall defect. The principle of management is to reduce the eviscerated content safely and to close the abdominal wall defect with an acceptable cosmetic appearance.

Objectives: Compare the using of Steri-drape Artificial Sac (SAS) and Alexis Wound Protector and Retractor (AWR) for staged closure of gastroschisis.

Methods: A retrospective study of patients with gastroschisis who were treated by staged closure at Queen Sirikit National Institute of Child Health between January 2013 and December 2016 was conducted. Patient's information was compared between the usage of SAS and AWR regarding demographic data, operative procedure and results of treatment. The statistical differences were analyzed by the Chi-square, Fisher exact and student t-test with p-value less than 0.05 considered significant. Patients who had associated intestinal atresia or perforation were excluded.

Results: Eighty-four patients with gastroschisis were treated by staged closure (SAS: 39, AWR: 45). Average gestational age, birth weight, maternal age and defect size in both groups were not significantly different ($p > 0.05$). AWR placements were performed at bedside 33 cases, in the operating room 7 cases. The AWR group had shorter operative time for placement and abdominal wall closure than SAS group significantly ($p < 0.001$). Regarding duration of parenteral nutrition, duration of ventilator support and length of stay, significantly shorter in the AWR group ($p < 0.05$). There were no complications attributed to AWR placement.

Conclusion: Staged closure of gastroschisis with AWR is simple, convenient and safe technique, in addition, to avoid anesthetic risk in the first day of life and good cosmetic appearance.

Keywords: Gastroschisis; Staged closure; Steri-drape artificial sac; Alexis wound protector and retractor; Surgical management

Introduction

Gastroschisis is a fully thick defect of the abdominal wall with herniation of a variable amount of uncovered intestinal loops through a defect immediately to the right of a normally formed umbilicus. The intestine is frequently foreshortened, covered with gelatinous exudates, matted together, and edematous due to its exposure to amniotic fluid and compression of the mesenteric blood supply at the defect.

The management of gastroschisis has gradually evolved and improved over the years. The principles of management, however, remain the same: to reduce the viscera safely, to close the abdominal wall defect with an acceptable cosmetic appearance, and proper nutrition support, in addition to detection and proper management of any associated anomalies or complications [1].

The safety of reduction and closure techniques are related to the level of Viscera Abdominal Disproportion (VAD). When primary reduction and facial closure under general anesthesia is impossible due to VAD and intra abdominal hypertension, staged closure with a silo is recommended. Surgical silo was created using a variety of materials (e.g., Prolene, Silastic, steri-drape and stockinette or intravenous infusion bag) [2-6]. The surgical silo with no suture is used in most Western setting. However, it is not performed in Thailand where the current procedure is a Steri-drape Artificial Sac (SAS) sutured directly to all layers of the abdominal wall circumferentially around the defect under general anesthesia.

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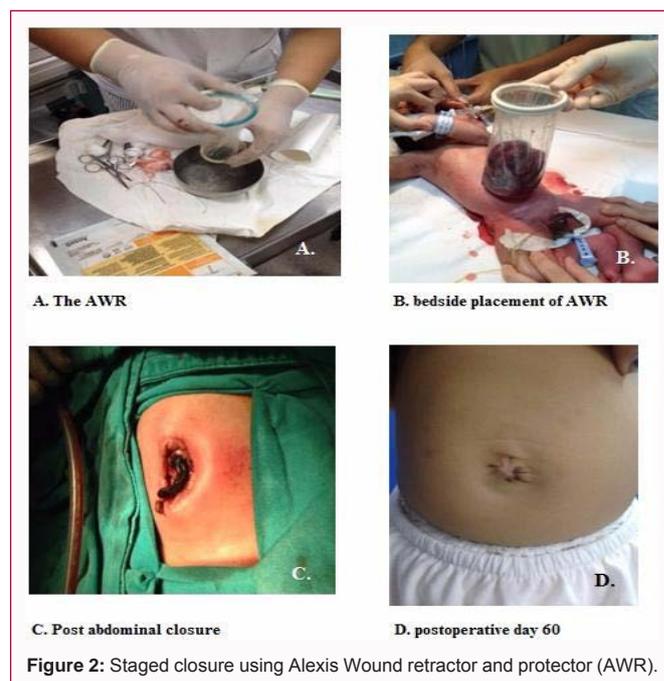
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The aim of this study is to compare the usage of SAS and Alexis Wound protector and Retractor (AWR) for staged closure of gastroschisis.

Material and Methods

After obtaining approval from the institutional Research Ethics Committee, a retrospective review was performed of all patients with gastroschisis who treated by staged closure at Queen Sirikit National Institute of Child Health (QSNICH) between January 2013 and December 2016.

Surgical techniques

Initial management aimed at maintaining circulation to the bowel and preventing infection by covering the defect with sterile dressing soaked in warm 0.9% normal saline to prevent fluid loss, stabilization infants within appropriate temperature, gastric decompression, and intravenous fluid with glucose and broad-spectrum antibiotics. After stabilization of the infants in the neonatal surgical unit, the herniated viscera was inspected and assessed for proper reduction method. The decision of primary closure was based on the size of the herniated viscera and the size of the abdominal cavity.

When primary closure was not possible due to the presence of discrepancy between the size of the herniated viscera and the volume of the abdominal cavity, a staged reduction of the herniated viscera and delayed closure of the abdomen was considered, then the silo pouch was fashioned by one of two methods as followed by the responsible surgeons. Half of the surgeon’s preferred SAS and the other half preferred AWR.

1. A Steri-drape Artificial Sac (SAS) used at QSNICH was described by Havanonda et al. [5] and Havanonda [6]. It is made of a stockinette pouch which is lined both inside and outside with steri-drape. The abdominal wall defect was extended upwards and downwards 2 cm to 3 cm. in order to prevent of obstruction during bowel reduction. The SAS was placed to cover over the herniated viscera and the defect. Continuous suturing was approximated between the SAS and all layers of the abdominal defect by non-absorbable sutures (2-0 nylon),

the upper limit of the SAS was closed with a simple tie with umbilical tape and the base was closed with gauze soaked in povidone iodine solution, as shown in (Figure 1). This procedure was done in the operating room under general anesthesia. In the second postoperative day the herniated viscera was manually reduce and daily cot-side reduction. When the viscera had been complete reduce, fascial and skin closure were achieved at a second anesthetic. The fascia defect was closed vertically with interrupted 2-0 polyglactin sutured and the skin was trimmed and approximated by interrupted stitches with umbilical cord preservation.

2. Alexis® Wound Retractor and protector (AWR) device (Applied Medical Resources Corp. USA) is a commercial wound protector and retractor system, made from polyurethane which is used for open laparotomy and hand-assisted laparoscopic surgery to protect the wound and is considered to be low reactivity to human tissue [7]. The AWR consisted of two rings, an elastic white one and elastic green one, a transparent rubber cylinder connects the two rings. This device is available in different diameters. We used the sizes XS with the ring diameter of 4 cm (Figure2). At the bedside under aseptic precaution, the AWR placement was performed. The herniated viscera were inserted into the retractor through the green ring, and then the bottom ring was placed into the peritoneal cavity through the gastroschisis defect without suturing to the fascia defect. Adhesion from the fascia to the bowel wall was gently disrupted manually. In case of dense adhesions to the bowel wall or very small gastroschisis defect, AWR placement was performed in the operating room under general anesthesia. Some time, because of the very small defect, a small skin incision in the midline is required for ring insertion. The diameter of the internal ring of AWR was not reduced as described in Japanese report [8]. The white ring is then gently lifted; avoid any leakage of peritoneal fluid out of the peritoneal cavity. The base of the AWR was closed with gauze soaked in povidone iodine solution and its upper limit was closed with a simple tie with umbilical tape. Over the next 2 days, the herniated viscera was gradually integrated the abdominal cavity, the cylinder was reduced with repeated tying until complete bowel reduction was obtained within 7 days. Following complete reduction,

Table 1: Demographic data.

Patient information	SAS	AWR	P-value
Total numbers (N)	39	45	
Male: Female (N, %)	22:17 (56.4:43.6)	18:27 (40:60)	0.189
Antenatal diagnosis by ultrasonography (N)	18 (46.2%)	24 (53.3%)	0.662
Gestational age (weeks, mean/range)	35.2 ± 2.0 (31-40)	35.3 ± 2.2 (30-40)	0.097
Birth weight (gms. mean/range)	2,117 ± 422.8 (1,500-3,165)	2,275 ± 462.0 (1,270-3,640)	0.727
Maternal age (years, mean/range)	19.8 ± 4.3 (13-31)	20.9 ± 5.9 (13-37)	0.637
Mode of delivery			
Normal labor	34 (75.6%)	31 (79.5%)	0.573
Cesarean section	11 (24.4%)	8 (20.5%)	
Birth order of mother			
First	23 (51.2%)	24 (61.5%)	0.425
Second and over	22 (48.8%)	15 (38.5%)	0.302
Defect size (cm, mean/range)	2.76 ± 0.67 (1.5-4)	2.75 ± 0.72 (1.5-4)	0.996

Table 2: Operative procedure and outcomes.

Operative procedure and outcomes	SAS	AWR	P-value
Average days of reduction (days, mean/range)	8.0 ± 2.17 (6-15)	7.7 ± 2.96 (5-20)	0.401
Operative time for placement of silo (minutes, mean/range)	67.69 ± 14.59 (45-105)	24.58 ± 12.14 (15-55)	<0.001
Operative time for closure of abdominal wall (minutes, mean/range)	65.89 ± 23.33 (35-155)	24.58 ± 9.55 (25-65)	<0.001
Time interval to 1st feeding (days, mean/range)	27.95 ± 12.2 (18-77)	22.71 ± 4.9 (14-40)	0.027
Time interval to full feeding (days, mean/range)	37.5 ± 14.3 (24-72)	31.27 ± 5.3 (25-46)	0.065
Time interval on PN (days, mean/range)	28.52 ± 10.08 (16-61)	23.26 ± 4.59 (16-36)	<0.001
Ventilatory support (days, mean/range)	12.17 ± 8.2 (1-30)	7.1 ± 5.4 (1-20)	0.034
Length of stay (days, mean/range)	41.41 ± 17.1 (27-86)	34.0 ± 6.4 (28-60)	0.043

the patients were returned to the operating room and abdominal defect was closed under general anesthesia as follows. Firstly, the AWR was removed without any difficulty then the peritoneum and fascia was approximated with interrupted 2-0 polyglactin sutured and the skin was closed with umbilical cord preservation.

Antibiotics were administered for 14 days, local wound care was performed. Feeding was commenced once nasogastric aspiration has become minimal and clear, patients were discharge home when feeding was full established.

Each patient was evaluated with regard to time to closure of the abdominal wall, time to initiating enteral feeds, time to full feeds, hospital course and any complications.

Data Analysis

Information evaluation included demographic data, technique of abdominal closure, and time interval to the first feeding, time interval to the full feeding, duration of Parenteral Nutrition (PN), Length of Hospital Stay (LOS) and result of treatment. Data is presented as mean, median, percentage and range. Mean comparisons used unpaired Student's t-test, unequal variances. Continuous data with skewness distribution comparisons used Willcoxon rank sum test. A p-value less than 0.05 were considered significant. Data processing was aided by the SPSS program version 20.0.

Results

Perinatal data

Between 2013 and 2016, 155 neonates with gastroschisis were

referred to Queen Sirikit National Institute of Child Health. Ninety-six patients were treated by staged closure, 12 patients had associated intestinal atresia or perforation and were excluded from this study. Eighty-four patients were evaluated.

Demographic data are highlight in Table 1. There were no difference ($p > 0.05$) concerning gender, antenatal diagnosis by ultrasonography, gestational age, birth weight, maternal age, modes of delivery, birth order of the mother and defect size.

Operative procedures

Eighty-four cases of gastroschisis underwent staged closure procedure. Thirty-nine cases had SAS placement and 25 cases were performed at night time. Forty-five cases had AWR placement, AWR was inserted bedside in the neonatal surgical unit without general anesthesia or sedative drug in 33 cases. Seven cases had a dense adhesion from abdominal wall to the bowel wall and 5 cases had a very small opening so AWR placements were performed in the operating room to allow lyses of adhesions or widening of the fascial defect with short operative time. Postoperatively, the daily dressing changes were performed in the neonatal unit. The eviscerated bowels were manually reduced in the second postoperative day. The average time for complete reduction was 8.0 days (6-15) and 7.7 days (5-20) for SAS and AWR respectively ($p = 0.401$). Three cases that underwent AWR placement in the operation room and widening of the defect had AWR dislodgement on third and fourth day after placement and replacement of AWR was performed in the operating room. The final staged, abdominal closure and umbilical preserved procedure in the operating room under general anesthesia were performed. The

Table 3: Comparison of postoperative complications between SAS and AWR groups.

Complications	SAS (n=39)	AWR (n=45)	P-value
Sepsis	10 (25%)	5 (11.1%)	0.096
Necrotizing enterocolitis	4 (10%)	3 (6.6)	0.699
Wound infection	6 (15.3%)	6 (13.3%)	0.748
Pneumonia	13 (33.3%)	2 (4.4%)	0.001
Respiratory failure	21 (53%)	13 (28.8%)	0.026
Prolonged paralytic ileus	1 (2.5%)	0	0.464
PN induced jaundice	2 (5%)	1 (2.2%)	0.595

mean operative time in SAS and AWR were 65.8 (35-155) and 24.5 (25-65) minutes (p<0.01), respectively. The AWR group had shorter operative time for placement and abdominal wall closure than SAS group significantly (Table 2).

Functional outcome measures were the mean time of first oral feeding and full feeding, duration of Parenteral Nutrition (PN), duration of ventilator support and length of stay. The duration from closure of abdomen to the first day of oral feeding range from 18-77 days (average 27.9) in SAS group and 14-40 days (average 22.7) in AWR group (p=0.027). The AWR group had earlier initial of enteral feeding, short duration of PN, short duration of ventilator support and short length of stay than SAS group significantly.

Septicemia occurred in 25% (n=10) in SAS group and 11.1% in AWR group (Table 3). The rate of NEC was 10% (n=4) in SAS group and 6.6% (n=3) in AWR group. Six wound infections were identified in each group. There was 1 death in this study, in detail; a 2,200 gm female was born at 36 weeks gestation by spontaneous vaginal delivery, APGAR 8, 9. She underwent SAS placement at age three hour post-delivery and abdominal wall closure at age seven days. However, at age of thirteen days, she was respiratory distress and developed respiratory failure. She ran down and died of septicemia bilateral pneumonia (*K. pneumoniae*).

Mean time of follow-up was 11 months (range 2 to 48 months). All patients had a normal weight gain. One case in SAS group underwent reoperation due to adhesive small bowel obstruction at 22 months old. At one year follow up, four cases in SAS group had a small umbilical hernia and three cases in AWR group had a small umbilical hernia that resolved during follow-up. The AWR group had less surgical scar and cosmetically acceptable appearance of the umbilicus.

Discussion

Gastroschisis is the most common congenital abdominal wall defect. The incidence of gastroschisis is rising over the last decade. It has been estimated between 4 to 10 in 10,000 live births [9-12].

There are five key consideration of surgical management of

Table 4: Reviewed of previous studies for using AWR.

Author	Year	No. of patients	Management	Under GA	Ventilatory support (days)	PN (days)	1 st feeding (days)	Full feeding (days)	LOS (days)	NEC (N)
Kusafuka [8]	2005	1	AWR	all	9	-	14	-	-	-
Ogasawara [18]	2009	7	AWR	all	5.7 (2-8)	-	11.1 (3-25)	-	48.5 (28-102)	-
Machida [20]	2011	2	AWR	all	0	-	16.5 (12-21)	-	36.5 (34-39)	-
Ferreira [19]	2014	8	AWR	all	4 ± 3 (median)	9.8 (5-23)	-	24.6 (15-45)	37.3 (20-56)	1 (12.5%)
This study	2018	45	AWR	12 (26%)	7.1 (1-20)	23.2 (16-36)	22.7 (14-40)	31.2 (25-46)	34 (28-60)	3 (6.6%)

GA: General Anesthesia; PN: Parenteral Nutrition; LOS: Length of Stay; NEC: Necrotizing Enterocolitis; N: Number

gastroschisis patients,

1. Reduce the evisceration safely,
2. Close the defect with a cosmetically acceptable outcome,
3. Identify and treat the associated anomalies,
4. Support nutrition until full independent enteral feeding is established and
5. Recognize and treat abdominal, wound or bowel complications [13].

In 1943, Watkins [14] reported the first successful primary closure of gastroschisis.

In 1975, Shermata and Haller [15] used a performed transparent silo sutured to the abdominal wall. The silo was suspended to allow relief of bowel edema and also to allow a gradual reduction of the viscera into the abdominal cavity.

In 1995, Fischer [2] used a silastic silo (Dow Corning, Midland, MI) with a spring-loaded ring (Ben Tec, Sacramento, CA) to place over the exposed viscera, under the fascial defect without suturing, performed under sterile condition in the NICU with patient sedation. The current method of treatment has change to the use of sutureless performed silo [16,17].

In Thailand, silastic sheet, spring loaded silo and sutureless silo is not available. In 1971, Havanonda [5,6] performed a steri-drape artificial sac which made from steri-drape and stockinette sutured directly to all layers of the abdominal wall circumferentially around the defect. This procedure was performed in the operating room under general anesthesia and left a long vertical surgical scar.

The use of AWR was first described in 2005 by Kusafuka et al. [8], as the usual spring-loaded silo was not available in Japan. AWR was used as a protective silo for staged closure of gastroschisis after having reduced the diameter of the internal ring. Four years later, Ogasawara et al. [18] reported the using of AWR in 7 patients. In 2014, Ferreira et al. [19] reported the used of AWR for staged closure of gastroschisis in 8 patients. All previous reports, AWR placement were performed in the operating room under general anesthesia [19].

This study was the first and largest published series of AWR for staged closure of gastroschisis in Thailand. The procedure was performed at bedside; avoid the need for first day surgery and general anesthesia. We usually used the size XS with the ring diameter of 4 cm. The ring can fit appropriately without urine retention or respiratory complication.

In the case that had a dense adhesion from abdominal wall to the bowel wall or a very small defect, we recommended to performed AWR placement in the operating room to prevent further injury to the eviscerated organs.

Although in 12 patients, the AWR placements were performed in the operating room under general anesthesia it's took shorter operative time than when performed SAS, which is a significant advantage. Three cases had AWR dislodgement, the causes of AWR dislodgement were widening of the all layers of the defect in placement procedure and shearing force when reduction the visceral content. Prevention could be divided only sheath when placement, care the AWR in central position of the defect and gradual reduction without traction the AWR. The gradual reduction of the viscera with the AWR minimized the risk for intra abdominal hypertension and visceral discoloration. The transparent nature of the AWR allows monitoring of visceral color that is not possible when SAS has been applied.

This study has limitations. Most importantly, the patients of each groups were not randomized due to it is a retrospective in nature. The surgical techniques were chosen by the responsible surgeons. Half of the surgeons preferred SAS, and the other half who concerned about general anesthesia in the first day of life preferred AWR. The responsible surgeons have preference of surgical technique regardless of the patient's condition.

We have demonstrated that placement of AWR device is feasible at the bedside in most infants (73% in this series), without the need for general anesthesia or sedation. This can preclude the need for "out of hours" operation, avoid surgery and general anesthesia on the first day of life. Comparison between cosmetic outcome of SAS and AWR, the AWR group had less surgical scar and cosmetically acceptable appearance of the umbilicus. Overall outcomes of AWR used are reviewed in Table 4.

Conclusion

The staged closure of gastroschisis with AWR is a simple, convenient and safe technique. The advantage of AWR use are reduce number of time to operation of patients, decrease anesthetic risk in the first 24 hour of life, reduce night time workload of physician, shorter length of stay when compare with the traditional method and in addition to being good cosmetic appeal. We concluded that AWR is to be an effective alternative and recommended device to use for staged closure of gastroschisis.

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