Outcome of management of gastroschisis: comparison of improvised surgical silo and extended right hemicolecotony

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Abstract

Background: Gastroschisis is one of the major abdominal wall defects encountered commonly in pediatric surgery. Whereas complete reduction and abdominal closure is achieved easily sometimes, a daunting situation arises when the eviscerated bowel loops and other viscera cannot be returned immediately into the abdominal cavity. This situation is a major contributor to the outcome of the treatment of gastroschisis in our region. In our efforts to improve our outcome, we have adopted the technique of extended right hemicolecotony for cases where complete reduction and primary abdominal wall closure is otherwise not possible. This study compared the management outcome of gastroschisis using our improvised silo, and performing an extended right hemicolecotony.

Results: Thirty-nine cases were analyzed. Simple closure could not be achieved in 28 cases. In the absence of standard silos, improvised ones were constructed from the amniotic membrane (3 cases), urine bag (4 cases), and latex gloves (9 cases) giving a total of 16 cases managed with silos. Extended right hemicolecotony was performed in 12 cases.

Conclusions: Given the peculiarities of circumstances in our region regarding human and material resources in the care of gastroschisis patients, an extended right hemicolecotony, to make it possible to close the abdomen primarily in gastroschisis is a more viable option than the use of improvised silo.

Trial registration: This trial was approved by the Ethical Committee of the University of Port Harcourt Teaching Hospital, Nigeria. Reference Number: UPTH/ADM/90/S.II/VOL XI/835. Registered 3 May 2013.

Keywords: Gastroschisis, Extended right hemicolecotony, Improvised silo, Closure, Morbidity, Mortality

Background

Gastroschisis is one of the major abdominal wall defects encountered commonly in pediatric surgery. It represents one of the most challenging defects requiring emergency surgical correction [1]. Treatment of this condition in sub-Saharan Africa has been met with high morbidity and mortality rates in the range of 30–100% [2–4]. This is in clear contrast with the scenario in the high-income countries where mortality rates are as low as 4% in many institutions [5–7]. The amount of viscera outside the abdomen varies from one case to the other. Also, associated anomalies like intestinal malrotation, bowel atresia, and undescended testis are common [8]. Whereas complete reduction and abdominal closure are achieved sometimes, a daunting situation arises when the eviscerated bowel loops and other viscera cannot be returned immediately into the abdominal cavity. A need to house the viscera temporarily outside becomes imperative. This comes with the requirements to control infection, support nutrition and support, if not take over, respiration. This inability to completely reduce the viscera in gastroschisis is related to the edema and matting together of the loops of the bowel due to prolonged exposure to amniotic fluid. Post-delivery, the edema is worsened by desiccation, minor trauma due to handling and infection. This is the basis some authors recommend...
early or premature delivery of these babies to reduce the
duration of contact with amniotic fluid [9–12]. However,
whether early delivery reduces mortality in gastroschisis is
yet to be scientifically tested. In our circumstance, many
of these patients come in already exposed to the assaults
of contamination, hypothermia, hypoglycemia, and some-
times desiccation of some parts of the viscera, and neo-
natal intensive care facilities and resources are limited
[13]. The use of silo in these circumstances is therefore
often met with discouraging results. We aimed in this
study, to compare the management outcome using surgi-
cal silo and performing an extended right hemicolectomy
in the treatment of gastroschisis.

Methods
A proforma was designed to retrospectively obtain
data from the medical records of consecutive cases of
gastroschisis managed in our units in our two health
institutions from June 2006 to May 2013. Ethical ap-
proval was obtained from the institutional review
boards of the two institutions where this study was
conducted. Written consent was also obtained from
the parents of the patients who were recruited pro-
spectively. We added the use of extended right hemi-
colec tomy (ERH) from 2013 and prospectively
obtained data from May 2013 to April 2018. We de-
de ned ERH as the surgical removal of the terminal
ileum about 3 cm proximal to the ileocaecal junction,
the caecum, ascending colon and more than half of
the transverse colon, followed by an ileotransverse
anastomosis. In all cases, efforts were made to reduce
the bowel and close the abdomen primarily. Before
May 2013, all cases that could not be closed had a
surgical silo (Silo group) but from 2013 such cases
were selected for extended right hemicolectomy (ERH
group). At surgery, the bowel was carefully inspected
for the presence of volvulus, atresia, or gangrene. The
bowel was cleaned using warm normal saline. Separ-
ation of the matted bowel loops was limited to only
the extent required to enable safe resection and anas-
tomosis. This was aimed at reducing blood loss,
though the majority received blood transfusion intra-
operatively. Any gas and or meconium in the matted
bowel was milked into the right hemicolon before its
excision. Any volvulus was untwisted, and any gan-
grenous segment incorporated into the resection
where possible. Data collected from the records of
the patients seen before 2013 included gender, age at
presentation and intervention, viscera seen on the
outside, method of repair, any nutritional support,
and outcome. The same data was obtained prospect-
ively from 2013. Data obtained were subjected to stat-
estical analysis on SPSS version 20.0. The level of
statistical significance was set at $p < 0.05$.

Results
A total of 43 infants with gastroschisis were seen in
the study period. Four infants were excluded due to
incomplete records and discharge against medical
advice. Thirty-nine patients were included in the
study. There were 22 (56.4%) females and 17
(43.6%) males. Prenatal diagnosis was made only in
2 (5.1%) patients. The mean age at presentation was
10.8 h ($\pm$ 3.2) for the Silo group, and 8.7 h ($\pm$ 2.1)
for the ERH group; $p < 0.1$. None of the patients re-
ceived standard parenteral nutritional support. All
patients in whom oral feeds could not be estab-
lished within 5 days received an amino acid infu-
sion. All patients went through similar protocols of
evaluation and resuscitation and general treatment.
Eight (20.5%) patients were seen within 6 h of deliv-
ery (Table 1) with less oedematous bowel (Fig. 1a)
whereas the rest were seen later (Fig. 1b). The most
common viscera exposed were the small and large
bowels (Table 2). Of the 39 patients analyzed, 2
(5.1%) died before any surgical intervention and 1
(2.6%) was unfit for any surgery and he died within
an hour of arrival. There was complete reduction
and primary fascial closure of the defect in 8
(20.5%) patients, and of these 2 died (25% mortality).
Skin closure could not be achieved in 28 (71.8%)
cases. In the absence of standard silos, improvised
ones (surgical silo) were constructed from amniotic
membrane (3 patients) (Fig. 2), urine bag (4 pa-
tients), and latex gloves (9 patients) giving a total of
16 patients managed with improvised surgical silos
(Silo group). One patient out of the 16 patients in
the silo group survived giving 6.3% survival (93.7%
mortality). Mortality in this improvised silo group
was related to severe sepsis, premature detachment
doing silo, lack of nutritional support and respiratory
failure. Extended right hemicolectomy was per-
fomed in 12 (30.8%) patients (ERH group). Eight
out of the 12 patients in this group survived giving a
66.7% survival. The morbidity and mortality in
this group were related to severe sepsis, anastomotic
leakage, and intestinal obstruction. All surviving pa-
tients were followed up for a mean period of 2.5
years. One patient who had a simple reduction and
primary closure developed intestinal obstruction 6
months after closure. A laparotomy revealed volvu-
lus of the midgut, and patient recovered fully the
following correction. One patient in the ERH group
developed post-op adhesive bands obstruction which
necessitated a second surgery. He also developed a
small incisional hernia which is being considered for
a repair. The outcome of the treatment options is
shown in Table 3. The difference in survival in the
Silo group and the ERH group was statistically
significant \((p < 0.05)\). Out of 36 patients who were treated for gastroschisis, 17 survived giving an overall survival rate of (41.7%).

**Discussion**

Gastroschisis ranks among the severe congenital anomalies that continue to pose a challenge to pediatric surgeons. The challenges which relate to morbidity and mortality include prematurity, low birth weight, compromised bowel, sepsis, and surgical complications [14, 15].

The majority of the patients in our study presented similar scenarios of low birth weight, viscera wrapped in an unclean wrapper, without proper warming of baby and moved over long distances to reach us. The picture is worse in the presence of atresia, bowel perforation, volvulus, or other anomalies [16]. In our series, there was only one case colonic atresia, and two cases of perforated and gangrenous bowel.

Despite advances in knowledge and technology, the outcome of treatment of gastroschisis is still less than expected for patients requiring surgical silo. Hence, researchers have tried and continue to try different maneuvers and techniques to further improve on what has been achieved [17]. Presently, standard surgical modalities for the treatment of gastroschisis, include reduction and primary fascial or skin flap closure, or partial reduction and use of silastic silo to allow for delayed fascial closure [18]. Primary fascial closure is the preferred method provided the entire viscera can be returned to the abdominal cavity without the risk of abdominal compartment syndrome or compromise of respiration. These are the principles we also used for our patients. However, in our circumstance, patients requiring silo treatment could only be treated with improvised ones as this study shows.

Some have recommended preterm delivery of these babies to reduce the deleterious effect of the amniotic fluid on the viscera [19]. This idea enhances outcomes where the majority of cases are diagnosed prenatally with imaging. Such imaging can also help in predicting the outcome of treatment [19, 20]. However, this method is not viable in our situation as prenatal diagnosis of gastroschisis is uncommon in our practice. Only three patients in this series were diagnosed prenatally. More so, the quality of neonatal intensive care available to us may not justify that mode of treatment [21].

The crux of this study was to address the peculiar management challenges in our region where the option of use of silo is attended with unacceptably high mortality. This study highlights the lateness of presentation and intervention with only 20.5% presenting within 6 h of birth and 11.1% being treated within that time frame. These challenges, in addition to lack of parenteral nutrition, functional neonatal intensive care units and pediatric ventilators have been reported by other researchers in our region [4, 22, 23]. We were constrained by the lack of standard silos to use amniotic membrane, latex gloves, drip bags, and urine bags at various times to improvise silos. We have also tried to adopt the innovative technique of sutureless gastroschisis closure

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**Table 1** Age of patients at presentation and at intervention

| Age (h) | 0–6 | 6–12 | 12–18 | 18–24 | 24–48 |
|--------|-----|------|-------|-------|-------|
| Patients at presentation \((n = 39)\) | 8 (20.5%) | 23 (59.0%) | 5 (12.8%) | 3 (7.7%) | – |
| Patients at time of intervention \((n = 36)\) | 4 (11.1%) | 7 (19.4%) | 13 (36.1%) | 7 (19.4%) | 5 (12.8%) |

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**Table 2** Viscera exposed at presentation

| Exposed viscera | Patients \((n = 39)\) | Percentages |
|-----------------|----------------------|-------------|
| Small bowel     | 39                   | 100         |
| Large bowel     | 37                   | 94.9        |
| Stomach         | 18                   | 46.2        |
| Urinary bladder | 9                    | 23.1        |
| Liver and gall bladder | 7       | 17.9        |

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Fig. 1 a Gastroschisis seen early. b Gastroschisis seen delayed
[24]. None of these gave us any result as encouraging as we have seen with extended right hemicolectomy.

Though gastroschisis had not been a common indication for colonic resection in our region, this trend may change with the findings of this study [25]. We noted in the course of this study, the technical difficulty of performing anastomosis in the edematous matted loops of bowel in gastroschisis. This indeed accounted for some of the mortalities in the ERH group. Contrary to our initial concerns, aside from the initial frequent stooling, there was no evidence of short bowel syndrome, poor weight gain, or impaired growth during the period of follow up in the patients who were treated with ERH.

An improvement from a survival rate of 6.3% in patients managed with our improvised silo to 66.7% in patients managed with extended right hemicolectomy and immediate fascial closure is remarkable. Though this does not measure up with the results reported by authors in the high-income countries, we consider it a significant advancement in our management of gastroschisis [3, 7].

We recognize the limitations of this study because of the small volume of patients, and the fact that the improvised silos are not standardized. A larger-scale multicenter study is required to properly test the option of extended right hemicolectomy and immediate fascial closure versus the use of surgical silo in the treatment of gastroschisis. However, our preliminary results in this study suggest that this technique has a potential to turn around the tide in the outcome of the treatment of gastroschisis in our region.

Conclusions
This study has demonstrated that gastroschisis still remains a major challenge in pediatric surgical practice in our region. Late presentation, delayed intervention, high infection rate, lack of parenteral nutritional support, and unavailability of standard silos remain our bane in the management of gastroschisis. Given these peculiarities of our circumstances regarding human and material resources in the care of these patients, and given the improved outcome with the option of extended right hemicolectomy, this second alternative is a more viable option than the use of improvised silo in our region.

Abbreviations
ERH: Extended right hemicolectomy; SPSS: Statistical Package for the Social Sciences

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Authors’ contributions
OPE conceived and conceptualized the idea of the study, did the literature review, data collection and collation, analysis of data, and manuscript writing. NC did the data collection and collation, data analysis, and critical review of the manuscript. Both authors read and approved the final manuscript.

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Availability of data and materials
All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Ethics approval and consent to participate
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Consent for publication
The consent for publication was verbally obtained from parents and guardians of the participants.

Competing interests
The authors declare that they have no competing interests.

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