GABBY: An *ex vivo* model for learning and refining the technique of preformed silo application in the management of gastroschisis

Natalie Dabbas, Zahid Muktar, Niyi Ade-Ajayi

ABSTRACT

Background: Gastroschisis (GS) is a congenital full-thickness defect of the anterior abdominal wall, whose incidence is increasing. Traditional postnatal management options include primary reduction and closure under general anaesthetic or operative silo construction for defects judged to be unsuitable for immediate repair. The cot-side application of the preformed silo (PFS) with delayed abdominal wall closure has recently been advocated as the management method of choice for infants with GS. We report a novel trainer designed to facilitate acquisition and refinement of the skills to apply the PFS. **Materials and Methods:** A model of an infant with GS was constructed to allow application of a PFS. Each step of the clinical application of a PFS could be simulated. Paediatric surgeons at a regional meeting participated in evaluating the model. This cohort was surveyed with regards to previous clinical experience applying the PFS, invited to apply the silo on the model and then resurveyed with regard to the technique, ease of the application of the PFS on the model, its robustness and potential use as a training tool. **Results:** Seventeen paediatric surgeons completed the surveys and applications of the PFS on the model. Under supervision, each step of the procedure was completed by all participants. Feedback was enthusiastic and positive and participants judged the model to be realistic and potentially very useful as a training tool (median score 8 out of 10). **Conclusions:** We have developed and evaluated a reproducible, low-cost model of an infant with GS. This *ex vivo* trainer may be a useful adjunct in the acquisition and refinement of the skills of surgeons who manage GS using a PFS.

Key words: *Ex vivo* training, gastroschisis, preformed silo

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Department of Paediatric Surgery, King's Hospital, Denmark Hill, London, UK

Address for correspondence:
Dr. Niyi Ade-Ajayi,
Department of Paediatric Surgery,
King's Hospital,
Denmark Hill, London SE5 9RS, UK.
E-mail: adeajayi@doctors.org.uk

INTRODUCTION

Gastroschisis (GS) is a congenital full-thickness defect of the anterior abdominal wall, whose incidence is increasing,[1-4] and may be as high as 4.4 per 10,000 live births.[5] Improvements in management have resulted in a substantial fall in mortality (6). Important factors in increased survival include better neonatal intensive care strategies and the widespread availability of parenteral nutrition.[6] The use of silos constructed from prosthetic materials is also thought to have been a significant contributor.[7]

Traditional postnatal management options include primary reduction and closure under general anaesthetic[8] or operative silo construction for defects judged to be unsuitable for immediate repair.[9] In 1998, Bianchi and Dickson[10] introduced the technique of cot-side reduction and closure without sedation or anaesthetic, but this has not found widespread acceptance.[11] Recently, the cot-side application of the preformed silo (PFS) has been advocated as the method of choice in infants with GS.[12] Several centres have reported encouraging outcomes, with putative benefits including a single delayed operative procedure, reduction of out-of-hours operating and improved physiological parameters.[6,13,14] However, some surgeons express concern about the potential technical difficulties of inserting the PFS in the awake infant.

The use of *ex vivo* trainers to enhance competence is now well established for both generic surgical skills[15,16] and specific procedures.[17,18] We report a novel trainer designed to facilitate acquisition and refinement of the skills to apply the PFS in the management of GS.

MATERIALS AND METHODS

A GS baby model (GABBY) was constructed using a commercially available toy doll (15" baby girl: You and Me©, product ref 97227/515164). A circular defect 3 cm in diameter was excised from the anterior abdominal

wall to the right of the umbilicus. The eviscerated bowel was simulated using bovine sausage, lubricated and partially placed within the abdominal wall defect. The volume of the eviscerated abdominal contents was standardized by length (50 cm, 70 cm and 90 cm).

GABBY was evaluated at a regional academic meeting of paediatric surgeons (March 2007, Institute of Child Health, London). Consultant and trainee surgeons were recruited into the study. Each was asked to complete a survey detailing their experience with the PFS and invited to apply one, under supervision, as they would on a live infant. This involved assessment of the defect and bowel volume, choice and then application of an appropriate-sized PFS (3.0-6.0 cm silicone silo; Medicina Ltd., Bolton, UK). Feedback was provided by participants completing a second questionnaire. This included questions regarding technical aspects of the use of GABBY and potential usefulness as a training tool. Responses were provided on a scale of 1-10, where 1 was unhelpful/unrealistic and 10 was very helpful/realistic. Data are presented as median with ranges.

RESULTS

Seventeen respondents applied the PFS on GABBY and completed pre- and postapplication surveys. These included five consultants (29.4%), 10 middle grade trainees (58.8%) and two junior trainees (11.8%). Under supervision, each participant successfully completed the following steps: An assessment of the eviscerated bowel and abdominal wall defect followed by choice of an appropriately-sized silo to fit the size of the defect and accommodate the bowel volume. A gentle finger sweep at the level of the defect to confirm that there was no mechanical impediment to smooth application and then insertion of the bowel into the silo with care to place the apex loop first and prevent rotational distortion (the position of the wings were noted) was performed. The circular spring-loaded base of the silo was then compressed into an oval and one edge of it was inserted first into the abdominal wall defect followed by the remainder of the base in sequence. Once the entire base of the silo was inserted into the defect, the springing of the base and the effect of this stabilizing the silo and the bowel were noted. The wings of the PFS were positioned at the 6 and 12 o'clock positions to avoid the position of the umbilical cord at 3 o'clock. Care was taken again to ensure that there was no rotational distortion of the bowel loops. The empty apical portion of the silo was then tied off using a sialastic sling [Figures 1-5].

Feedback was enthusiastic and positive and participants judged the model to be realistic and potentially very useful as a training tool [Figure 6] [median score 8 out of 10 (range 5-10), where 10 was very realistic/potentially very useful as a training tool].

DISCUSSION

A study from Bristol in 1998 raised concerns regarding the rising incidence in the southwest of England. It demonstrated an increased incidence from 1.6 to 4.4/10,000 in the period 1987-1995.[19] This trend has been confirmed in other regions of the UK, prompting the chief medical officer to identify GS as "a growing concern" in his 2004 annual report. Upward trends have been demonstrated in several countries including Japan[20] and Norway.[4] In Utah, the incidence has increased 10-fold over three decades.[1] There are strategic implications for health care providers with regard to resource utilization and service delivery related to increases of this degree.

Some aspects of the management of GS remain contentious; in particular, the use of a silo and delayed abdominal closure versus primary surgical closure on day 1 of life.

In 1975, Shermeta and Haller[12] introduced the principle behind the PFS to protect eviscerated bowel while allowing time and pressure to produce gradual expansion of the abdominal cavity. The turn of the century has seen the use of modified versions of the PFS in several centres. A number of reports appear to validate putative benefits, including cot-side placement without anaesthesia, reduced ventilation time and reduction in the incidence of compartment syndrome.[13,20,21] The immediate coverage of exposed viscera and gradual reduction into the abdominal cavity may reduce the risk of homodynamic and respiratory compromise associated with primary closure of large defects,[14,22-24] although not all users report positive results.[25] Specifically, there have been concerns regarding the risk of intestinal ischaemia related to the use of the PFS.

We have been using the PFS in our unit since 2004 and recently compared 13 infants managed with a PFS and delayed closure with 40 who underwent traditional closure.[26] The group managed with the PFS was associated with a reduction in barotrauma, better tissue perfusion and better early renal function. These findings are consistent with a reduction in abdominal compartment syndrome and, along with others,[27] we expect trends to favour this method of managing GS. Based on our experience, we recognize that while application of a PFS is a simple technique when mastered, at the outset, cot-side insertion is challenging



Figure 1: Gastroschisis baby model demonstrating eviscerated bowel protruding through the anterior abdominal wall defect

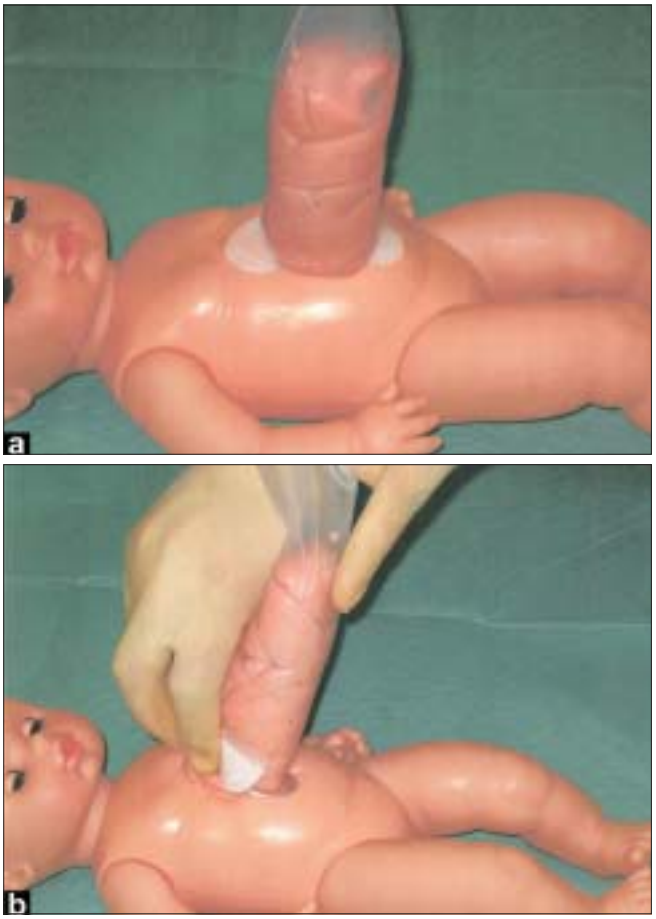


Figure 3(a and b): Gastroschisis baby model demonstrating insertion of the spring-loaded base of the preformed silo into the anterior abdominal wall defect



Figure 5: Gastroschisis baby model following application of a preformed silo



Figure 2: Gastroschisis baby model during insertion of the bowel into the preformed silo



Figure 4: Gastroschisis baby model demonstrating application of tie to create mild intraabdominal tension

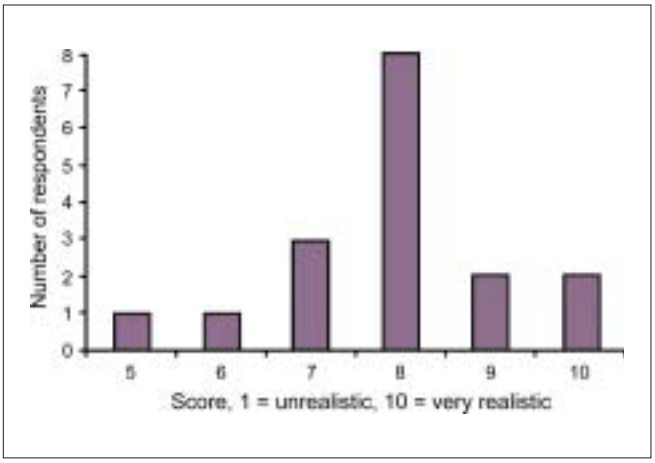


Figure 6: Bar chart reflecting the view of respondents regarding how realistic the model was (1 = unrealistic, 10 = very realistic)

to learn in the live, nonventillated infant. The use of an *ex vivo* model allows each step of the technique to be learned and refined.

Respondents who went on to choose and apply the PFS on GABBY did so with considerable enthusiasm, as reflected in the high scores regarding potential usefulness and authenticity of the model. Reservations were expressed by two vegetarians about bovine sausage. In the short term, this is easily rectified by the use of vegetarian sausage where required.

Experience extrapolated from laparoscopic surgery suggests that *ex vivo* training may be a valuable tool during the introduction of novel techniques to departments and individuals, helping to reduce the duration of the learning curve and the risk of adverse clinical consequences.[28] Some surgeons may accept the principles of gradual reduction, yet be dissuaded from using the PFS as a result of lack of hands-on experience. In this subset of potential users, GABBY could help build confidence in the technique, support practice and facilitate the training of junior surgeons. If the model is to be used regularly within a unit, there is the current drawback of having to obtain fresh material from the butcher each time the model is required. We are currently exploring the possibility of an appropriate synthetic replacement.

We have successfully evaluated a simple and reproducible model suitable for the *ex vivo* insertion of a PFS. Given the increased incidence of GS worldwide and the increasing use of the PFS with delayed abdominal wall closure, GABBY could become an important training tool in the management of this condition.

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