



The correlation between the time spent in utero and the severity of bowel matting in newborns with gastroschisis



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ABSTRACT

Background: Optimal timing of delivery in fetuses with gastroschisis (GS) is unknown. Some favor early induced delivery to prevent bowel injury. This study evaluates the correlation between bowel injury and the gestational age at birth using the Gastroschisis Prognostic Score (GPS).

Methods: A national database was analyzed from 2005 to 2013. Patients were pooled based on their gestational age at birth. The mean GPS and % of patients with severe bowel matting were tabulated for each week in utero. Regression modeling was used to evaluate the relationship between the dependent (severe matting and GPS) and independent (gestational age) variables and the R^2 coefficient of determination was derived to evaluate model strength. Additional factors influencing the timing of delivery were evaluated.

Results: Of 780 cases, 88 were excluded because of missing data. A linear relationship is seen between increasing gestational age and decreasing bowel matting ($R^2 = 0.66$) and GPS ($R^2 = 0.72$). For every week in utero, the % of patients with severe matting decreases by 3.6%.

Conclusion: Early induced delivery simply to protect the bowel from ongoing in utero damage appears unfounded and should be reserved for evidence of closing gastroschisis or traditional obstetrical/fetal indications.

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Gastroschisis (GS) is one of the most common congenital abdominal wall defects and is usually detected in the prenatal period in developed countries during routine fetal ultrasound and selective maternal serum screening [1–3]. Despite frequent intrauterine growth restriction (IUGR) and premature delivery, most babies with GS survive with an excellent outcome; only 5%–10% have severe bowel damage and require prolonged intravenous nutrition [4]. The exact cause of bowel injury remains unknown. Putative causes include chemical irritation by urine, meconium or regurgitated digestive enzymes in the amniotic fluid; other possibilities include the restriction of venous and lymphatic outflow because of a narrow abdominal wall defect [5–8]. A few authors have blamed prolonged labor as the cause of bowel edema and have advocated for routine cesarean section (CS) as a consequence [9–12].

Several authors have advocated for preterm delivery to prevent potential serious complications including ongoing bowel damage in utero as well as third trimester fetal demise, fetal distress with neurological sequelae [13] and a risk of “closing gastroschisis” leading to massive midgut loss [14,15]. Elective preterm delivery has been associated with a shorter hospital stay, faster initiation to oral feeding [16,17], a higher proportion of successful primary repair, and a shorter duration of mechanical ventilation [9,17]. On the other hand, preterm delivery has conversely been shown to increase the duration of hospitalization and delay the time required to reach full oral feeding [18–20].

In addition, premature GS babies are at higher risk of developing sepsis and cholestasis [4,21,22]. Many studies have been underpowered to detect significant outcome differences based on delivery practices, including the only prospective randomized trial published to date [23–25]. Additional limitations of the salient literature include the prolonged time span included in most studies resulting in the comparison of patients treated in different eras, inclusion of emergency and elective deliveries as well as the evaluation of patients without stratification based on disease severity.

In order to assess whether preterm delivery protects the bowel from ongoing damage in utero, the Canadian Pediatric Surgery Network (CAPSNet) database was used to correlate the time spent in utero with the severity of bowel matting and Gastroschisis Prognostic Score (GPS) in newborns with gastroschisis [26]. The study hypothesis was that if the proponents of preterm delivery were correct, we should see a higher percentage of severe matting and high-risk GPS with increasing gestational age.

1. Methods

1.1. Study population

The Canadian Pediatric Surgery Network includes all tertiary care Canadian perinatal centers and has collected data on all congenital diaphragmatic hernia and GS cases from fetal diagnosis until hospital discharge or death since May 2005. CAPSNet is nested within a national, universal health care delivery plan without appreciable private maternal

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Table 1
Gastroschisis Prognostic Score (GPS).

Matting	None (0)	Mild (1)	Severe (4)
Atresia	Absent (0)	Suspected (1)	Present (2)
Perforation	Absent (0)		Present (2)
Necrosis	Absent (0)		Present (4)

Prospectively collected clinical findings at first patient encounter were assigned a numerical score based on logistic regression analysis. Patients with a GPS <2 are considered at low risk for morbidity and mortality. A GPS ≥2 identifies patients with higher risks of morbidity and mortality. Reproduced with permission from Cowan et al. [26].

Table 2
Demographic information and select outcomes for gastroschisis patients included in analysis.

Parameter	n = 692
Male, n (%)	365 (52.8)
Gestational age, weeks (median; IQR)	36 (35–37)
Birth weight, grams (mean ± SD)	2538 ± 516
GPS, median (IQR)	1 (0–1)
GPS low risk, n (%)	534 (78)
LOS, median days (IQR)	36 (25–62)
Survival, n (%)	679 (98)
Severe bowel matting, n (%)	83 (12)
1st attempt successful closure, n (%)	582 (84)
Delivery type, vaginal, n (%)	470 (68)

IQR = interquartile range (1st quartile–3rd quartile); GPS = Gastroschisis Prognostic Score; LOS = length of stay.

or neonatal hospital care. Screening maternal ultrasounds are routinely performed during the second trimester, and often in the first and third trimesters for low-risk pregnancies; private ultrasounds remain available as desired. The diagnosis of GS on prenatal screening typically triggers a prompt referral to a CAPSNet center for further surveillance, counseling and antenatal care.

After obtaining approval from the CAPSNet steering committee and our hospital's Research Ethics Board (14-081-PED), the CAPSNet data registry for cases of GS for the years 2005–2013 was accessed and analyzed. Individual patient data was prospectively collected in the registry as previously described [3]. Briefly, a trained research assistant at each participating center abstracted prenatal and postnatal data using a customized data entry program and a standardized manual of operations and definitions with built-in error checking. The coded, de-identified data were then transmitted electronically to a centralized,

secure database for cleaning and storing. This process was overseen by a study coordinator and a multidisciplinary, geographically representative, steering committee consisting of a neonatologist, pediatric surgeons, a maternal–fetal medicine specialist, and an epidemiologist.

1.2. Bowel injury assessment

Before the onset of CAPSNet data collection, standard definitions for bowel matting, necrosis, atresia and perforation were agreed upon (available at <http://www.capsnetwork.org/portal/Resources/EducationfortheGSBowelInjuryScore.aspx>). For each GS patient, a bowel injury assessment form was prospectively filled at the time of first clinical evaluation by the treating surgeon or surgical fellow: (http://www.capsnetwork.org/portal/Portals/0/CAPSNet/Worksheets/GS%20Pre-Op%20Record%20-%20V1.1.1_Nov%202013.pdf). After several years of data collection, the GPS tool was developed and validated, providing a prospectively collected risk-stratification tool (Table 1) [26]. A GPS score of 0 or 1 is considered low-risk, while 2 or more places the child at higher risk of mortality and morbidity including a prolonged length of stay.

1.3. Statistical analysis

The analysis was restricted to neonates with complete data regarding GPS and gestational age (GA) at birth. To evaluate the relationship between gestational age at birth and matting/GPS, regression modeling was performed for all gestational weeks with at least 3 patients within (excluding <29 weeks and >40 weeks gestational age). Since isolated mild bowel matting has previously been demonstrated not to influence prognosis [26], only severe bowel matting was examined as a dependant variable, as well as overall GPS. Linear and nonlinear regression models were tested to investigate the association between the dependent (matting and GPS) and independent (gestational age) variables; the R^2 coefficient of determination was derived to evaluate model strength, with $R^2 = 1$ indicative of a perfect correlation.

Secondary variables investigated include other parameters that significantly influence timing of delivery, including the mode of delivery (cesarean or vaginal delivery), the presence and adherence to a birth plan, and whether or not an induction was performed. For each of these, the incidence (%) of severe bowel matting, high-risk GPS score, and the percentage of successful primary closure were evaluated. For the secondary outcomes, the data obtained were analyzed using Fisher's

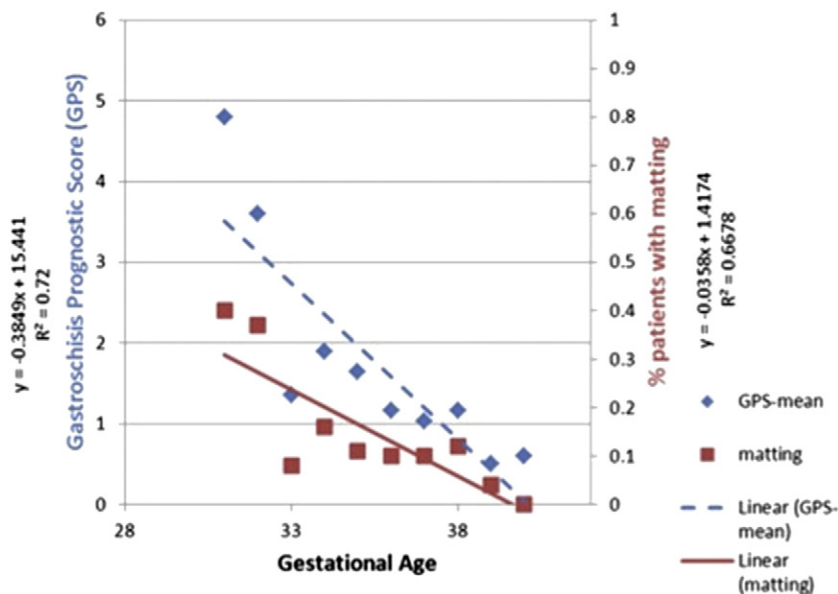


Fig. 1. Regression graph showing a linear relationship between increasing gestational age and decreasing incidence of severe bowel matting and overall Gastroschisis Prognostic Score.

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