Journal of Pediatric Surgery 50 (2015) 102–106

Contents lists available at ScienceDirect

Journal of Pediatric Surgery

journal homepage: www.elsevier.com/locate/jpedsurg

A risk-stratified comparison of fascial versus flap closure techniques on the early outcomes of infants with gastroschisis

Claudia N. Emami [a], Fouad Youssef [a], Robert J. Baird [a], Jean-Martin Laberge [a], Erik D. Skarsgard [b], Pramod S. Puligandla [a,*] The Canadian Pediatric Surgery Network (CAPSNet)

[a] The Division of Pediatric General and Thoracic Surgery, The Montreal Children's Hospital of the McGill University Health Centre, Montreal, Quebec, Canada, H3H 1P3
[b] Division of Pediatric Surgery, British Columbia Children's Hospital, University of British Columbia, Vancouver, British Columbia, Canada, V6J 4K7

ARTICLE INFO

Article history:
Received 28 September 2014
Accepted 6 October 2014

Key words:
Gastroschisis
Fascial closure
Umbilical flap closure
Surgical outcomes
Gastroschisis prognostic score

ABSTRACT

Background: While fascial closure is traditionally used in gastroschisis (GS), flap closure (skin or umbilical cord) has gained popularity. We evaluated early outcomes and complications of the two techniques.
Methods: A national, population-based gastroschisis data registry was analyzed from 2005 to 2011. We compared fascial to flap closures and stratified patients into low or high-risk groups using the Gastroschisis Prognostic Score (GPS), a validated marker of post-natal bowel injury. Demographic and outcome data, including length of stay, complications, and markers of resource utilization were analyzed using Fisher's exact and Student's t-tests for categorical and continuous variables, respectively ($p<0.05$ significant).
Results: The analyzed dataset included 436 fascial closures (344 [78.8%] low-risk, 92 high-risk) and 129 flap closures (112 [86.7%] low-risk, 17 high risk; $p=0.06$). Demographics and birth weight did not differ between groups. In patients with low GPS, flap closure demonstrated significant decreases in resource utilization and failure of closure, without differences in complication rates. Analysis of high-risk patients revealed no statistically significant differences in outcome.
Conclusion: Flap closure was not associated with an increase in patient morbidity and seemed suitable as a definitive closure method for gastroschisis patients irrespective of disease severity. Furthermore, flap closure reduced several markers of resource utilization in patients with low-risk disease.

Operative fascial closure with sutures has been the traditional method to close the abdominal wall defect observed in gastroschisis (GS). This can be achieved either upon presentation or after serial reduction using a silo. In 2004, Sandler et al. [1] described a "plastic sutureless" technique for defect closure using the umbilical cord remnant. Other similar "flap" closure techniques have also been previously described [2,3]. These techniques have the purported advantages of efficiency and cost effectiveness as they may be performed at the bedside with minimal sedation, thereby mitigating the need to transport an infant to the operating room. Subsequent single center retrospective studies evaluating this technique have demonstrated fewer ventilator days, lower rates of sepsis and surgical site infection [4], as well as reduced rates of parenteral nutrition [5] when compared to traditional suture closure [6].

The use of the sutureless closure has experienced an almost 3-fold increase in Canada over the last 5 years [7]. The motivation for this increase is unclear but may be related to the ease of the technique and the reduced need for resource allocation. While initial reports [4–6,8] have limited this technique predominantly to cases of uncomplicated gastroschisis, there is increasing experience using this technique in patients with complicated gastroschisis. However, the suitability of the sutureless closure for this specific population of patients needs to be better defined. The overall aim of the current study was to compare the outcomes and complications of primary fascial closure with the flap technique, *until hospital discharge or death*, using a population-based registry of gastroschisis patients across Canada. Furthermore, we sought to specifically address the applicability of the flap closure for all patients with gastroschisis, irrespective of complexity, by comparing outcomes between simple and complicated cases of gastroschisis after risk-stratifying patients using the validated gastroschisis prognostic score (GPS) [9].

1. Methods

After obtaining approval to perform this study from the Director of Professional Services at the Montreal Children's Hospital for use of the CAPSNet database for outcomes research (OCC2011-354), we analyzed the CAPSNet data registry for cases of gastroschisis for the years 2005–2011. Data were prospectively collected as previously described [10]. Briefly, a trained research assistant at each participating CAPSNet 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 data, stripped of patient identifiers, were then transmitted electronically to a centralized, secure

* Corresponding author at: Division of Pediatric General and Thoracic Surgery, The Montreal Children's Hospital, 2300 Tupper, Room C811, Montreal, QC, Canada, H3H 1P3. Tel.: +1 514 412 4438; fax: +1 514 412 4289.
E-mail address: pramod.puligandla@mcgill.ca (P.S. Puligandla).

http://dx.doi.org/10.1016/j.jpedsurg.2014.10.009
0022-3468/

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

The analysis was restricted to neonates with complete GPS and method of closure information within the CAPSNet database. The GPS has been previously described as a validated tool for morbidity and mortality risk stratification in gastroschisis [9], and is calculated within hours of birth based on an evaluation of the severity of bowel matting and necrosis, as well as the presence of intestinal perforation or atresia. A GPS ≥ 2 identifies patients with higher risks of morbidity and mortality while low risk patients have scores <2. For the purposes of our analysis, the entire study cohort was initially divided into low and high-risk GPS groups. Next, these groups were further segregated based on the method of closure into either "fascial" or "flap" closure. Fascial closure was defined as those repairs in which the fascia was reapproximated using suture material. Flap closures were defined as those in which the umbilical cord remnant and/or surrounding skin was used to obtain coverage of the abdominal wall defect without the use of fascial sutures. Comparisons were made regarding basic demographic data as well as the primary outcome of length of stay in hospital (LOS). Secondary outcomes analyzed included days *nil per os* (NPO), days of parenteral nutrition (TPN), complications (wound infection, wound dehiscence, abdominal compartment syndrome) location of abdominal wall defect repair, timing of definitive closure, and the use of inhaled anesthetic. Flap and fascia closures were segregated into an early (2005–2008) and late (2009–2011) 'era' to evaluate trends in closure technique utilized over time. The data obtained were analyzed using Fisher's exact and two-tailed Student's t-tests for categorical and continuous variables, respectively ($p<0.05$ significant).

2. Results

A total of 701 eligible GS cases were available from the CAPSNet data registry during the study period. Demographic data on the study cohort based on the GPS risk stratification are shown in Table 1, with high-risk patients having significantly lower survival rates and increased lengths of stay compared to low-risk patients. After subjects were excluded for missing data, 565 patients remained of which 436 had primary fascial closures and 129 had flap closures. Demographic data for the fascia and flap closure cohorts are presented in Table 2. The fascial and flap closure groups were similar with respect to birthweight (BW), gestational age (GA), median GPS and the proportion of low-risk GPS patients within each group, as well as length of stay (LOS). Survival was excellent, with both groups experiencing rates ≥98%. There was increased utilization of the flap closure in the low risk group in 2009–2011 vs. 2005–2008 (P=0.003). While the number of flap closures in the high-risk group doubled in the latter era, this increase did not reach statistical significance (P=0.1). Of note, the BW and GA for excluded patients were also similar to those included for study (data not shown).

Table 3 depicts the comparisons of the fascial and flap closure groups within the low-risk GPS cohort. Pre-closure silo use was equivalent irrespective of the method of closure. Low-risk patients who underwent flap closure had statistically similar lengths of stay and mortality when compared to infants undergoing fascial closure. There were also no significant differences between the two groups with respect to the timing of closure (<6 h or >24 h after birth) or feeding parameters, which included days NPO and the number of days on TPN. Compared to fascial closures, flap closures were more likely to be successful within the low-risk group (p=0.006). Closures that failed were managed with either a spring-loaded silo (75%) or a sutured silastic sheet (25%). While flap closure patients were more likely to be repaired outside of the operating room (ICU or other) without the use of inhaled anesthetics when compared to fascial closures, there were still a significant proportion of flap closures (34/112) that physically occurred in the operating room (OR). "Other" location for defect closure was a site outside of the OR or ICU, and likely represented the delivery case room. It was noted that none of these "other" patients required inhaled anesthetics (i.e.) not ventilated, and that 6 flap closures succeeded while the two attempted fascial closured failed (Table 2). Patients undergoing flap closure demonstrated a significant reduction in ventilator days, with 13.4% of these patients (n=15) completely avoiding intubation. A sub-group analysis of flap closure patients demonstrated that significantly fewer patients repaired in the ICU required general anesthesia compared to those closed in the operating room (5/78 vs 26/34; p<0.0001). Overall, the aggregate complication rate did not differ based on closure method but there was a trend towards reduced wound infection rates in those

Table 1
Demographic data based on GPS stratification.

Parameter	Low-Risk (n=456)	High-Risk (n=109)	P value
Gestational Age (weeks)	36 (33–40)	36 (34–38)	–
Birth weight (g)	2655 ± 593	2453 ± 115	–
GPS	1 (0–1)	5 (2–12)	–
Survival, n (%)	452 (99)	102 (94)	***P<0.01**
LOS, days	31 (5–430)	62 (4–626)	***P=0.01**
Pre-closure silo, n (%)	346 (75)	71 (65)	***P<0.03**
Era 2005–2008	Fascia:188 (81) Flap: 44 (19)†	Fascia: 62 (91) Flap: 6 (9)‡	
Era 2009–2011	Fascia: 148 (69) Flap: 68 (32)†	Fascia: 24 (77) Flap: 7 (23)‡	

Data are presented either as mean ± SD or median (range). GPS = gastroschisis prognostic score; LOS = length of stay in hospital. "Era" refers to number of patients in each group born during the two defined time periods having either fascial or flap closure. Data were analyzed using Fisher Exact Tests with p<0.05 considered significant (*).
† P=0.003 between eras.
‡ P=0.1 between eras.

Table 2
Demographic data for fascial and flap closure patients.

Parameter	Fascial Closure (n=436)	Flap Closure (n=129)
Male, n (%)	232 (53)	61 (48)
Gestational Age (median; weeks)	36 (24–40)	36 (26–41)
Birthweight (mean; g)	2537 ± 517	2595 ± 510
GPS; median (range)	1 (0–12)	1 (0–6)
GPS low risk; n (%)	344 (79)	113 (88)
LOS; median days (range)	36 (4–626)	31 (4–430)
Survival, n (%)	427 (98%)	127 (98.5%)

Data are presented either as mean ± SD or median (range). GPS = gastroschisis prognostic score; LOS = length of stay in hospital;

Table 3
Summary table of low-risk gastroschisis patients (GPS <2).

	Fascial Closure n=344	Flap Closure n=112	P value
Inhaled Anesthetics; n (%)	232 (67)	31 (28)	***P<0.0001**
Closure Location (OR v ICU v other)	310 v 32 v 2	34 v 72 v 6	***P<0.0001**
Silo pre-closure; n (%)	256 (74)	90 (80)	P=0.25
Closure < 6 h; n (%)	166 (48)	50 (47)	P=0.51
Closure > 24 h	141 (41)	42 (38)	P=0.58
Closure success; n (%)	302 (88)	108 (96)	***P=0.006**
Aggregate Complications (%)	148 (43)	44 (39)	P=0.51
Wound Infection; n (%)	38 (11)	6 (5.4)	P=0.09
ACS	5 (1.4)	0	P=0.34
Days Ventilated	4 (0–28)	3 (0–23)	***P=0.01**
Days NPO	12 (4–215)	12 (2–77)	P=1.0
Days TPN	25 (2–401)	26 (8–373)	P=0.75
Length of stay	32 (2–395)	30 (6–430)	P=0.95
Mortality; n (%)	3 (1)	1 (1)	P=1.0

Data are presented as median (range). GPS = Gastroschisis Prognostic Score; OR = operating room; ICU = intensive care unit; "other" – location of closure outside of OR and ICU; NPO = nil per os; TPN = parenteral nutrition; ACS = abdominal compartment syndrome. Data were analyzed using Fisher Exact Tests with p<0.05 considered significant (*).