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Incisional hernia repair after caesarean section: a population based study

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Abstract

BACKGROUND

Incisional hernias occur at surgical abdominal incision sites but the association with caesarean section (CS) has not been examined.

AIM: To determine whether CS is a risk factor for incisional hernia repair.

MATERIAL and METHODS: Population-based cohort study in Australia using linked birth and hospital data for women who gave birth from 2000 to 2011. (n=642,578) Survival analysis was used to explore the association between CS and subsequent incisional hernia repair. Analyses were adjusted for confounding factors including other abdominal surgery. The main outcome measure was surgical repair of an incisional hernia.

RESULTS: 217,555 women (33.9%) had at least one CS and 1,554 (0.2%) had an incisional hernia repair. The frequency of incisional hernia repair in women who had ever had a caesarean section was 0.47%, compared to 0.12% in women who never had a caesarean section. After controlling for different follow up lengths and known explanatory variables, the adjusted hazard ratio (aHR) was 2.73 (95%CI 2.45-3.06, P <0.001). Incisional hernia repair risk increased with number of caesarean sections: women with two CS had a threefold increased risk of incisional hernia repair, which increased to 6 fold after five CS (aHR=6.29, 95%CI 3.99-9.93, P<0.001) compared to women with no CS. Prior abdominal surgery including other hernia repair also increased the risk of incisional hernia repair (all p<0.001).

CONCLUSIONS: There was a strong association between maternal CS and subsequent incisional hernia repair, which increased as the number of CSs increased, but the absolute risk of incisional hernia repair was low.

KEYWORDS incisional hernia, caesarean section, population-based

Introduction

Incisional hernias occur through a weakness at the site of abdominal wall closure, unlike other abdominal wall hernias, which occur through anatomical points of weakness[1]. This defect allows for parts of the intestinal tract or other organs to herniate into the subcutaneous layers of the abdomen, which may become incarcerated in the abdominal wall. Patients with an incisional hernia may suffer discomfort, unsightly abdominal distension or less commonly incarceration or bowel obstruction[2]. Surgical repair is indicated if the hernia is symptomatic or associated with complications. The repair may involve placement of mesh via either an open or laparoscopic approach and may be associated with morbidity and recurrent hernia formation[1]. Post-operative increased intra-abdominal pressure is associated with incisional hernia formation[1].

Established patient risk factors for incisional hernia such as diabetes, older age, renal failure, immunosuppression and atherosclerosis occur in relatively low frequency in women of reproductive age[1]. Obesity, another established risk factor for incisional hernia, is increasing in people of all ages, including women of reproductive age[3]. Surgical factors associated with incisional hernia formation include midline skin incisions, long surgical incisions, emergency surgery, surgical site infections factors associated with increased intra-abdominal pressure in the immediate post-operative phase such as ileus, coughing, and mechanical ventilation[1, 4]. Surgical techniques also influence incisional hernia formation[5]. A recent study of driving after caesarean section highlighted the lack of information for women about time-to-drive

after caesarean section, and raised questions about the possible adverse consequences of driving soon after surgery[6]. Another study highlighted the lack of consensus about activity restrictions to prevent incisional hernia after colorectal surgery[7].

There is wide variation in rates of incisional hernia occurrence after laparotomy. A recent meta-analysis found an incidence of ventral incisional hernia of 11% in vertical skin incisions and 4.7% in transverse skin incisions, although the majority of patients in that study had undergone gastrointestinal, bariatric, urological or vascular surgery[4]. In a review of 848 cases where a Pfannenstiel incision was used for obstetric, gynecologic, prostate or appendectomy surgery with follow up of 0.5-14 years, the rate of incisional hernia was reported as 0.0-2.1%[8].

Caesarean sections made up over a quarter of births (26.9%) in the Organization for Economic Cooperation and Development (OECD) countries in 2011, with caesarean section rates rising in most countries from 2000-2011[9]. There is a lack of evidence about whether caesarean section is a risk factor for incisional hernia. The aim of this study was to determine whether caesarean section is a risk factor for incisional hernia.

Methods

The study population included women who gave birth in New South Wales (NSW), Australia in 2000-2011. Approximately one-third (approximate n=90,000 per annum) of all Australian births occur in NSW, which has a resident population of about 7 million people.

We used anonymised information from two linked population health datasets: the New South Wales (NSW) Perinatal Data Collection (PDC) from 2000-2011 and the NSW Admitted Patient Data Collection (APDC) from 2000-2011. The PDC is a population based surveillance system that records all births in NSW of at least 20 weeks gestation or at least 400 grams birth weight[10]. Information recorded by the midwife/doctor in the PDC includes maternal demographic characteristics, maternal health, pregnancy, labour, birth, and infant outcomes. The APDC is a census of all NSW inpatient hospital discharges (public and private) and includes demographic and episode-related data; diagnoses and procedures are coded from the medical records according to the 10th revision of the International Statistical Classification of Diseases and Related Health Problems, Australian Modification (ICS-10-AM) and the affiliated Australian Classification of Health Interventions for each admission[11]. Record linkage of the PDC and APDC was undertaken by the NSW Centre for Health Record Linkage using probabilistic record linkage[12]. The record linkage validity is high,[13] and for this study the quality assurance measures were reported as 3 per 1000 false positive links and <5 per 1000 missed links. Ethics approval for the study was obtained from the NSW Population and Health Services Research Ethics Committee.

The primary outcome was surgical repair of an incisional hernia. This was obtained from hospital procedure codes (repair of incisional hernia, repair of incisional hernia with muscle transposition, repair of incisional hernia with prosthesis, repair of incisional hernia with resection of strangulated intestine) but does not include the site of the incisional hernia. Hernia repair is reliably identified in Australian hospital data. A validation study found that compared with medical records, identification of hernia repair in hospital data has an ascertainment rate of 94%, and a positive predictive value of 100%[14].

The exposures of interest were any caesarean section and the number of prior caesarean sections. Other factors potentially predictive of incisional hernia that were available for analysis included other abdominal surgery and perinatal factors. Other abdominal surgery was classified as open abdominal, laparoscopic and previous hernia repair surgery (femoral, inguinal umbilical). Categories of surgery were not mutually exclusive, and surgery may have occurred before or after the last birth, but must have occurred prior to the incisional hernia repair. Perinatal factors at last birth included maternal age, country of birth, socioeconomic status (the Australian Bureau of Statistics Index of Relative Socio-economic Disadvantage), private obstetric care, multi-fetal pregnancy, parity, maternal medical/pregnancy conditions, (including chronic renal disease, diabetes, hypertension, asthma, thyroid disorders, autoimmune diseases and morbid obesity), smoking during pregnancy, preterm birth <37 weeks gestation, large-for gestational age (LGA >90th birthweight for gestational age percentile) [15]. Perinatal data are known to be reliably reported in birth or hospital data[16, 17].

Missing data were infrequent: age at last birth 0.03%, county of birth 0.3%, parity 0.09%, socioeconomic status 0.3% and LGA 0.3%.

Analysis

Women's reproductive histories were created and the last birth prior to incisional hernia repair or before the end of the study period (whichever came first) was determined. Women with an incisional hernia repair prior to their first birth (n=99) and women with only an incisional hernia diagnosis code (i.e. no evidence of a repair, n=878) were excluded. Women whose caesarean section history was not known were also excluded (n=7604). (Figure 1)

Descriptive statistics were used to summarize the distributions of maternal and pregnancy characteristics among women with and without any caesarean section. Cox proportional hazards models were employed to determine the association between both any caesarean section and the number of caesarean sections, and time to subsequent incisional hernia repair. Women contributed follow-up time until time of an incisional hernia repair or the end of the study. In the multivariate survival analysis, a backward elimination approach was used to drop out non- significant terms with the highest *P*-value progressively until all terms remaining were significant ($P<0.05$, two-sided). Terms that were removed were added to the final model one at a time to assess whether they became significance and were confounders of the effect of caesarean sections (i.e. changed its effect by >10%). Crude and adjusted hazard ratios (HR) and 95% confidence intervals (95%CI) are reported.

Results

Among the 642,578 women with known prior caesarean section status, 217,555 (33.9%) had had at least one caesarean section and 1,554 (0.2%) had had an incisional hernia repair subsequent to childbirth. The characteristics of women by caesarean section status are presented in Table 1. Women who had had a caesarean section were more likely than women who had not had a caesarean delivery to be older, have a chronic medical condition, be born in Australia/ New Zealand, be a private patient at the time of their last birth, and have higher socioeconomic status (all $p<0.001$). Women who had had a caesarean section were also more likely to have had previous surgery (open abdominal, laparoscopic and/or prior hernia repair, all $p<0.001$) than women who had not had a caesarean section. The median (interquartile range) follow up time was 4.49 years (2.21-7.75) and 4.70 years (2.24-8.23) for women with and with a caesarean section respectively.

The frequency of incisional hernia repair in women who ever had a caesarean section was 0.47% compared to the frequency of incisional hernia repair of 0.12% in women who never had a caesarean section (unadjusted HR=3.94, 95%CI 3.55-4.38, $p<0.001$). After adjusting for all explanatory variables (including abdominal surgery), women who had ever had a caesarean section had more than two and a half times the risk of incisional hernia repair compared to women who had never had a caesarean section (adjusted HR= 2.73, 95%CI 2.45-3.06, $p <0.001$).

Table 2 presents the risk factors for incisional hernia. There was a dose response association between incisional hernia repair and number of previous caesarean sections. After adjusting for all variables, women who had ≥2 caesarean sections had a more than 3 fold or more increased rate of incisional hernia compared to women who had had no previous caesarean sections (table 2). Women who had had previous surgery (open abdominal, laparoscopic and previous hernia repair) also had increased rates of incisional hernia repair that remained significant after adjusting for all variables (all $P<0.001$). Asthma or chronic obstructive pulmonary disease, morbid obesity and autoimmune diseases were all associated with an increased risk of incisional hernia after adjusting for all variables (all $P <0.005$), while women born in Asia had a lower risk of incisional hernia repair compared to women born elsewhere (aHR 0.29, 95%CI 0.21-0.38, $p<0.001$).

Discussion

We found a strong association between maternal caesarean section and subsequent incisional hernia repair, and a strong association between increasing number of caesarean sections and increasing risk of incisional hernia repair. The rate of incisional hernia repair after a single caesarean section however was low.

The strength of this study is the large population-based data over a 10 year time period, in which women could be tracked over time in different hospitals in NSW. We included women who had a surgical repair, rather than just women who had a diagnosis code. We were able to adjust for maternal demographic characteristics and perinatal exposures, including morbid obesity, chronic medical conditions, the number of caesarean sections a woman had had and other open abdominal and laparoscopic surgeries. Surgical procedures are well reported in hospital data[14]. Our study also has face validity as women with established risk factors for incisional hernia including smoking, diabetes, autoimmune disorders, obesity, renal disease and older age had a higher risk of incisional hernia repair[1]. Use of survival analysis allowed us to account for variable length of follow up time after childbirth.

One of the limitations of this study was that it was not possible to ascertain whether the incisional hernia repair was at the caesarean section incision, or another surgical incision site. However the analysis accounted for other abdominal surgery and other perinatal and demographic factors, and showed a dose response consistent with a causal association.

There was also a strong association between other abdominal surgery, including prior incisional hernia repair, and incisional hernia repair. We included women who had an incisional hernia repair subsequent to childbirth and caesarean section. Patient level data on factors such as body mass index, or detailed clinical or surgical information were not available. In addition, women who delivered towards the end of the study period had limited length of follow up.

Apart from a number of small single centre studies in high risk populations, the rate of incisional hernia repair after childbirth has not previously been reported. It was noted by Browne in his paper published in 1965 from Dublin that "the state of the abdominal wall in some cases of multiple repeat delivery is deplorable"[18]. In their series a ventral wall hernia was found in 3/182 (1.6%) women who had 3 or more caesarean sections, and in 2/43 (4.7%) women who had had ≥6 caesarean sections. A case series from Nigeria showed that 22/701 (3.1%) women who had a caesarean section had an incisional hernia, however the authors state that of the 22 women who developed an incisional hernia all had had a midline skin incision[19]. A study from Pakistan showed a 5.6% rate of incisional hernia after midline caesarean section[20].

Caesarean section is routinely performed in a lower transverse skin incision in Australia. In uncommon cases, such as when hysterectomy is planned for suspected placenta accreta or concurrent gynecological cancer, then a subumbilical or less commonly supraumbilical,

midline skin incision may be performed at caesarean section. However, rates of caesarean section vertical skin incision of 2.6% have been reported in a multicentre study in the United States, as this was thought to be a more rapid way to deliver the fetus in an emergency situation[21].

A meta-analysis of studies has shown lower rates of incisional hernia with continuous (vs. interrupted) technique (OR 0.59; P = 0.001) and with slowly absorbable (vs. rapidly-absorbable) suture material (OR 0.65; P = 0.009) in the elective setting[5]. In order to prevent incisional hernia in a vertical abdominal incision, it is recommended to use a small needle on a slowly absorbable suture in a continuous running suture with a suture to wound ratio of 4:1[22]. The National Institute of Clinical Excellence in the United Kingdom states “in the rare circumstances that a midline abdominal incision is used at caesarean section, mass closure with slowly absorbable continuous sutures should be used because this results in fewer incisional hernias and less dehiscence than layered closure”[23]. Wound infection after caesarean section is reduced with prophylactic antibiotics [24]. In light of this study, in addition to closing vertical abdominal incisions with slowly absorbable sutures such as Polydioxane (PDS) rather than rapidly absorbable sutures, obstetricians should also consider the use of slowly absorbable sutures in women who are at risk of incisional hernia because they have had multiple caesareans.

A reduced risk of incisional hernia repair was observed among women born in Asia compared to women born in Australia/New Zealand. A Swedish population based study of mainly Nordic born individuals has shown a familial association of occurrence of different types of abdominal wall hernias, including incisional hernia repair, suggesting a genetic predisposition to hernia formation[25]. That study also found an association between spouses having abdominal wall hernias, and the authors hypothesized that there may also be a lifestyle component to hernia formation. However, there were low rates of non-Nordic born individuals in that study. It is not known whether there may be genetic/ tissue differences or lifestyle differences including exercise, weight, smoking, diet or alcohol intake that may contribute to differences in hernia formation in different populations. There are a number of cultural practices related to activity restriction in the puerperium that many Asian women may adopt, which may be different from those of women born in other countries[26], including limiting physical activity, avoiding cold air and water, including bathing, and eating certain types of food.

This study provides further information about the long term complications of caesarean section. There is a recognised association between caesarean section and long term, rare maternal morbidities, including placenta accreta and placenta praevia, hysterectomy and chronic pelvic pain[27]. Further attention should be directed towards prevention of incisional hernia, by exploring potentially modifiable factors such as surgical techniques. In addition, further efforts could be directed towards prevention of the first caesarean section.

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Table 1: Characteristics of the 642,578 women by caesarean section (CS) status

	Any CS (n=217,555) N (%)	**No CS** (n=425,023) N (%)	**P**
Prior surgery other than CS			
Open abdominal surgery	20,712 (9.52)	3,922 (0.92)	<0.001
Laparoscopic surgery	39,236 (18.0)	55,555 (13.1)	<0.001
Other hernias/prior hernia repair	1,858 (0.85)	2,479 (0.58)	<0.001
Maternal characteristics at last birth			
Country of birth			<0.001
Australia/New Zealand	153,191 (70.7)	298,168 (70.3)	<0.001
Asian	32,473 (15.0)	63,190 (14.9)	
Other	31,109 (14.4)	62,550 (14.8)	
Socio-economic status			<0.001
Most disadvantaged	40,273 (18.7)	92,825 (22.0)	
Disadvantaged	39,008 (18.1)	85,175 (19.6)	
Average	43,066 (20.0)	88,353 (20.3)	
Advantaged	43,483 (20.2)	84,629 (19.4)	
Most advantaged	49,214 (22.9)	81,678 (18.7)	
Any chronic medical condition*	13,310 (6.12)	13,941 (3.28)	<0.001
Pre-existing diabetes	2,880 (1.32)	2,050 (0.48)	<0.001
Pre-existing hypertension	6,032 (2.77)	6,665 (1.57)	<0.001
Chronic renal diseases	440 (0.20)	323 (0.08)	<0.001
Asthma/Chronic obstructive	2,124 (0.98)	2,489 (0.59)	<0.001
Thyroid disorders	876 (0.40)	1,254 (0.30)	<0.001
Autoimmune diseases	1,050 (0.48)	1,104 (0.26)	<0.001
Morbid obesity	1,370 (0.63)	827 (0.19)	<0.001
Pregnancy factors at the last birth			
Age at the last birth (years)			<0.001
<20	3,114 (1.43)	14,074 (3.31)	
20-34	137,655 (63.3)	308,808 (72.7)	
≥35	76,726 (35.3)	101,977 (24.0)	
Parity 0	69,446 (32.0)	139,389 (32.8)	<0.001
Parity 1-2	126,021 (58.0)	237,940 (56.0)	
Parity ≥3	21,667 (9.98)	47,483 (11.2)	
Smoking	24,627 (11.3)	59,429 (14.0)	<0.001
Multiple pregnancy	8,276 (3.80)	4,524 (1.06)	<0.001
Private patient	86,548 (39.9)	114,489 (26.9)	<0.001
Placenta praevia/accreta	4,751 (2.18)	1,017 (0.24)	<0.001
Gestational DM	17,977 (8.26)	24,291 (5.72)	<0.001
Pregnancy Hypertension	23,004 (10.6)	28,157 (6.62)	<0.001
Preterm birth <37 weeks	21,621 (9.94)	21,234 (5.00)	<0.001

Infant size >90th percentile	30,345 (14.0)	43,602 (10.3)	<0.001

* Pre-existing diabetes, pre-existing hypertension, chronic renal disease, Asthma/Chronic obstructive airway disease, thyroid disorders, autoimmune diseases, morbid obesity

Table 2: Risk factors for Incisional hernia in 641,580* women in whom the total number of caesarean sections (CS) was known

	Unadjusted HR	P	Adjusted^ HR	P^
Total CS number				
0	1.00		1.00	
1	2.58 (2.26-2.94)	<0.001	2.16 (1.88-2.48)	<0.001
2	4.38 (3.84-5.00)	<0.001	2.99 (2.59-3.44)	<0.001
3	7.91 (6.71-9.31)	<0.001	3.88 (3.25-4.64)	<0.001
4	10.9 (8.23-14.3)	<0.001	3.81 (2.80-5.18)	<0.001
5	20.9 (13.5-32.3)	<0.001	6.29 (3.99-9.93)	<0.001
Prior surgery other than CS				
Open abdominal surgery	6.88 (6.12-7.74)	<0.001	2.57 (2.25-2.93)	<0.001
Laparoscopic surgery	4.19 (3.79-4.63)	<0.001	2.70 (2.43-2.99)	<0.001
Other hernias/prior hernia repair	24.8 (21.7-28.4)	<0.001	12.6 (11.0-14.6)	<0.001
Maternal characteristics				
Age at the last birth (years)				
<20	0.37 (0.21-0.66)	<0.001	0.63 (0.36-1.13)	0.12
20-34	1.00		1.00	
≥35	1.66 (1.50-1.84)	<0.001	1.29 (1.17-1.43)	<0.001
Country of birth				
Australia/New Zealand	1.00		1.00	
Asian	0.20 (0.15-0.27)	<0.001	0.29 (0.21-0.38)	<0.001
Other	0.97 (0.85-1.11)	0.66	1.03 (0.90-1.19)	0.64
Private patient at the last birth	1.27 (1.15-1.41)	<0.001		
Socio-economic status				
Most disadvantaged	1.00			
Disadvantaged	0.97 (0.83-1.14)	0.70		
Average	1.09 (0.93-1.26)	0.30		
Advantaged	1.08 (0.94-1.27)	0.26		
Most advantaged	0.85 (0.73-1.00)	0.05		
Smoking	1.32 (1.16-1.50)	<0.001	1.19 (1.04-1.37)	0.01
Pre-existing diabetes	2.27 (1.55-3.32)	<0.001		
Pre-existing hypertension	2.55 (2.04-3.20)	<0.001	1.47 (1.16-1.86)	0.002
Chronic renal diseases	3.03 (1.36-6.75)	0.007		
Asthma/Chronic obstructive pulmonary disease	3.06 (2.27-4.14)	<0.001	1.84 (1.35-2.51)	<0.001
Thyroid disorders	2.14 (1.24-3.68)	0.006		
Autoimmune diseases	3.18 (2.00-5.06)	<0.001	1.97 (1.23-3.13)	0.005
Morbid obesity	5.69 (3.77-8.58)	<0.001	1.92 (1.26-2.93)	0.002
Pregnancy factors at the last birth				
Gestational DM	1.75 (1.49-2.06)	<0.001	1.37 (1.16-1.61)	<0.001
Pregnancy Hypertension	1.69 (1.45-1.96)	<0.001	1.27 (1.08-1.48)	0.003

Parity				
0	1.00		1.00	
1-2	1.78 (1.55-2.04)	<0.001	1.18 (1.01-1.37)	0.04
≥3	2.97 (2.52-3.49)	<0.001	1.30 (1.08-1.57)	0.006
Multiple pregnancy	1.81 (1.40-2.34)	<0.001		
Preterm birth <37 weeks	1.55 (1.32-1.84)	<0.001		
Infant size >90th percentile	1.63 (1.44-1.86)	<0.001	1.21 (1.06-1.38)	0.005
Placenta praevia/accreta	2.10 (1.45-3.05)	<0.001		

*998 women for whom the number of caesarean sections was unknown were excluded from this analysis

^ Adjusted for all the variables in the column.

Figure 1. Flowchart of women in the study