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Pregnancy and delivery after lower body contouring surgery is safe for the mother and child

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Summary *Background:* Obesity in fertile age women has increased worldwide leading to increased bariatric procedures. Lower body contouring surgery (LBCS) is one of the most commonly performed esthetic operations, mainly owing to massive weight loss. However, there is a paucity of data regarding pregnancy and delivery after LBCS. In this study, we examined whether LBCS influences pregnancy or delivery and mother and baby outcome.
Methods: In this national registry-based study, we used data from the Finnish Institute of Health and Welfare and the Causes of Death registry. We included fertile age women, from 18 to 54 years who had LBCS with or without a bariatric procedure and who experienced pregnancy and delivery were compared to all deliveries in Finland during 1999– 2016.
Results: We identified 92 women who had LBCS before delivery. These 92 women had planned cesarean sections more often ($P < .001$) and preterm delivery was more common ($P < .001$). None of the mothers or babies died. Of the 92 women, 26 had a preceding bariatric procedure. The preceding bariatric procedures did not increase the risk for preterm delivery or low birth weight. The need for urgent or emergency sections was not increased. The heightened number of planned cesareans is caused by the different demographics of the study group, indicating that previous LBCS is not a contraindication for vaginal delivery.

Preliminary results of this study were presented in the 30th EURAPS May 23–25, 2019, Helsinki, Finland
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Conclusion: Pregnancy and delivery are safe for the mother and the baby after LBCS. The possible deviations from normal pregnancy and delivery should be discussed with fertile age women seeking LBCS.

Introduction

Obesity in women of childbearing age has increased worldwide over recent decades, and more patients undergoing bariatric surgery are fertile age women.[1-3] Recent publications report that bariatric surgery has an overall positive effect on maternal and neonatal outcomes by reducing the risk of gestational diabetes, hypertensive disorders, maternal complications during delivery, fetal macrosomia, and preterm delivery.[3,5] The effect of bariatric surgery on subsequent pregnancy and delivery has been actively studied.[6,8] Further, bariatric surgery seems to decrease the risk of cesarean and instrumental delivery.[9]

Lower body contouring surgery (LBCS), such as abdominoplasty, is often sought at different stages of body image development.[10] Typically, lower body figure deformities result from massive weight loss or pregnancy.[11,12] Because of a multiplicity of etiologies leading to functional and esthetic problems in the lower body, abdominoplasty is one of the most commonly performed esthetic operations, and its popularity continues to increase.[13-15] Particularly after massive weight loss, problematic surplus skin and laxity of the tissues may appear circumferentially in the lower body thus demanding a body lift.[13,16,17] While abdominoplasty addresses the anterior abdominal contour, a body lift addresses the circular lower body.[16] The goal of these procedures is to improve the form and return the original anatomy and function by reducing excess skin and fat, placing the scars unnoticeably, and thus reaching a lasting effect. In cases of rectus muscle diastasis, the rectus sheath can be plicated in the vertical plane.[16,18,19]

Until now, LBCS – that is abdominoplasty [20] or body lift – has not been advised when the patient plans to become pregnant soon after the operation. The main explanation provided is that after LBCS, reduced flexibility of the abdominal wall may endanger the health of both the mother and unborn child.[20,21] Pregnancy may also hinder the esthetic result of LBCS. Thus, pregnancy is considered a relative contraindication for LBCS.[22] In the past, abdominoplasty, and particularly rectus plication, has been deemed hazardous to the fetus and even the termination of the pregnancy was recommended.[23] However, there is a noticeable paucity of research evidence on pregnancy and delivery after LBCS. Table 1 summarizes previously published articles, the majority of which are case reports.[20,21,23,24]

The aim of this present study was twofold. First, we sought to resolve whether LBCS – abdominoplasty or body lift – affects pregnancy or delivery. Second, we aimed to study whether preceding bariatric surgery has an additional effect on pregnancy or delivery.

Patients and methods

The Helsinki University Hospital review board approved the study and its plan. Permissions to use the registered information on bariatric patients in scientific research were obtained from the Finnish Institute of Health and Welfare and Statistics, Finland, after the data protection authority was consulted. The Medical Birth Register was then queried for pregnancies and deliveries of the included women. Causes of death register provided information on death and their causes. Information from the different registers was merged through record linkages using personal identification numbers (PIC). All citizens and permanent residents in Finland have a unique PIC, which was introduced during the years 1964–1967. The PIC used in all main registers in Finland allows reliable deterministic record linkage.

Data included all fertile age women (from 18 to 54 years) who had LBCS performed before pregnancy and delivery in Finland during 1999–2016 as recorded in the Hospital Discharge Register. The included lower body contouring operations were identified based on appropriate surgical procedure codes. The codes came from The NOMESCO Classification of Surgical Procedures (NCSP), which was published for the first time in 1996. Codes indicating lower body contouring procedures were abdominoplasty (QBJ30), body lift (QBJ05), and other esthetic correction on skin of trunk (QBJ99).

Bariatric procedures were identified from surgical procedure codes for gastroplasty (JDF01) and gastric bypass (JDF11). The data were further analyzed by dividing patients into two groups depending on whether there had been a bariatric procedure before the LBCS. Both groups were compared to all pregnancies and deliveries during the study period.

Entry fields included in the study were: patient's age, timing and the type of bariatric surgery procedure, body contouring surgery year and type, time between LBCS and pregnancy, parity, the length of the pregnancy, termination of pregnancy, miscarriage, preterm birth (<37 weeks), mode of delivery, and low birth weight (<2500 g). The visits to maternity and hospital clinics during pregnancy were recorded. Predelivery diagnoses were also recorded. Self-reported body mass index (BMI) in early pregnancy has been recorded in the Medical Birth Register since 2004. BMI was divided into five classes: <18.5 (underweight), 18.5–24.9 (normal weight), 25–29.9 (pre-obesity), 30–34.9 (obesity, class I), and ≥35 (obesity class II, III).

Statistical methods and analysis

Differences between bariatric surgery patients with and without subsequent postbariatric LBCS were tested using

Table 1 Literature review on the effect of the LBCS in pregnancy and delivery.

First author, Year	Type of study	Procedures	Latency between operation and pregnancy	Mode of delivery	Outcome, remarks.
Menz, 1996	Case report	Abdominoplasty+ rectus plication	5 years	Cesarean section	No adverse effect to abdominoplasty wounds
Borman, 2002	Case report	Abdominoplasty	2 months	NA*	1 year after delivery, the abdominal wall had regained tone like after abdominoplasty
Nahas, 2002	Case report	Abdominoplasty + rectus plication	23 months	NA	4 months after delivery no rectus diastasis, good improvement of the abdominal contour without the need of any other abdominal procedure
Pimental, 2016	Congress abstract	Abdominoplasty	NA	cesarean section and vaginal delivery	Cesarean section in 49%

(* NA not available).

the chi-squared test, the test of relative proportion and the *t*-test, where appropriate. Odds ratios (OR) with 95% confidence interval (CI) were calculated for dichotomous variables and weighted mean differences were calculated for continuous variables. All analyses were done using SAS, version 9.3. Both groups were compared to each other and to all deliveries during the study period.

Results

All patients, all pregnancies, and deliveries

In Table 2, we summarize the data for all deliveries after LBCS and compare with all deliveries ($n = 1\ 028\ 503$) in Finland during the study period. We recorded altogether 122 deliveries in this cohort. In summary, the women with preceding LBCS were older ($P < .001$), had higher BMI in early pregnancy ($P < .001$), had shorter length of pregnancy ($P = .009$), had cesarean sections more often ($P < .001$), and had more outpatient clinic visits in hospital during pregnancy ($P < .001$).

All patients' first pregnancies

Our focus was on first pregnancies after LBCS, and the specific inclusion criteria resulted in 92 women who had LBCS before pregnancy and delivery. Table 2 summarizes the data for demographic characteristics and provides a statistical comparison between the first pregnancies and deliveries after LBCS and all first deliveries ($n = 564\ 447$) in Finland during the study period. None of the mothers or children died because of pregnancy or delivery.

The women with preceding LBCS were older ($P < .001$), had a shorter mean length of pregnancy ($P = .019$), and had more outpatient clinic visits in the hospital during pregnancy ($P < .001$). Cesarean sections were more common in women who had LBCS ($P < .001$), with considerably more planned cesarean sections ($P < .001$). However, there were no statistical differences for urgent (decision to delivery < 30 min) cesarean sections ($P = .103$) or emergency (immediate delivery) cesarean sections ($P = .216$).

Women with preceding LBCS had more preterm births, <37 weeks ($P < .001$), and previous miscarriages after LBCS ($P = .027$). There was no significant statistical difference for low birth weight ($P = .138$), number of previous induced termination of pregnancies ($P = .163$), or visits in maternity clinics during the pregnancy ($P = .466$).

Bariatric group

The bariatric group comprised 26 women (28.3%). There were 33 deliveries altogether in this group, and all first pregnancies were singleton.

There were 22 (84.6%) patients who had gastric bypass (JDF11), one (3.8%) had gastroplasty (JDF01), and 3 (11.5%) had other bariatric procedures. There were 23 (88.5%) abdominoplasty and 3 (11.5%) body lift procedures in the post-bariatric group. The majority (92.3%) of LBCS procedures were done in public hospitals and the rest in private hospitals. The mean latency between LBCS and delivery was 2.67 years (range: 1.04–6.52 years). The mean age was 35.9 years and mean BMI in early pregnancy was 32 years. There were 2 (7.7%) women who had one or more terminations of pregnancy and 8 (30.8%) women who had one or more previous miscarriages.

The mean length of pregnancy was 271.2 days (SD 18.3). Low birth weight (< 2500 g) was recorded in 15.4% of deliveries. Two (7.7%) women had preterm delivery (<37 weeks). Eighteen (69.2%) had vaginal deliveries and 8 (30.8%) cesarean sections. In total, 5 (19.2%) planned sections and 3 (11.5%) urgent sections were recorded. There were no emergency sections in this group. In all, 53.8% had no prior births, 15.4% had one previous birth, 19.2% had two births, 7.7% had three births, and 3.8% had four births. No women had 5 or more prior births in this group.

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Table 2 The first and all pregnancy and deliveries after LBCS.

	First pregnancy and delivery after LBCS (%)	First pregnancy and deliveries in Finland (%)	p-value	All pregnancy and deliveries after LBCS (%)	All pregnancy and deliveries in Finland (%)	p-value
n	92	564,447		122	1,028,503	
Mean age (SD)	33.5 (5.1)	29.6 (5.6)	<0.001	34 (5.1)	30.1 (5.4)	<0.001
BMI* < 18.5	2 (2.3%)	50,995 (11.6%)	<0.001	4 (3.3%)	50,995 (6.8%)	<0.001
18.5-24.9	21 (24.4%)	181,993 (41.3%)		24 (19.7%)	181,993 (24.3%)	
25-29.9	31 (36.0%)	71,062 (16.1%)		41 (33.6%)	71,062 (9.5%)	
30-34.9	16 (18.6%)	25,581 (5.8%)		21 (17.2%)	25,581 (3.4%)	
35-	13 (15.1%)	1238 (0.3%)		21 (17.2%)	1238 (0.2%)	
Unknown	3 (3.5%)	110,232 (25%)		3	110,232	
Mean length of pregnancy (SD)	274.2 (16)	278.1 (13)	0.019	274.5 (15.2)	278.1 (13.5)	0.009
Singleton	90 (97.8%)	555,015 (98.3%)	0.707	118 (96.7%)	1,013,259 (98.5%)	0.101
Low birth weight, (<2500 g)	7 (7.6%)	24,982 (4.4%)	0.138	9 (7.4%)	45,865 (4.5%)	0.118
Preterm delivery (<37 weeks)	8 (8.7%)	13,881 (2.5%)	<0.001	10 (8.2%)	53,650 (5.2%)	0.139
Postterm delivery (>42 weeks)	0	29,888 (5.3%)	0.023	2 (1.6%)	47,272 (4.6%)	0.119
Vaginal delivery	60 (65.2%)	457,391 (81.0%)	<0.001	86 (70.5%)	858,855 (83.5%)	<0.001
Cesarean section	32 (34.8%)	106,438 (18.9%)		36 (29.5%)	168,669 (16.4%)	
Planned	19 (20.7%)	38,821 (6.9%)	<0.001	20 (16.4%)	70,386 (6.8%)	<0.001
Urgent	11 (12.0%)	42,247 (7.5%)	0.103	14 (11.5%)	64,189 (6.2%)	0.017
Emergency	2 (2.2%)	5271 (0.9%)	0.216	2 (1.6%)	8496 (0.8%)	0.321
Other	0	20,099 (3.6%)	0.065	0 (0%)	25,598 (2.5%)	0.078
Parity 0	28 (30.4%)	365,428 (64.7%)	<0.001	28 (23.0%)	365,428 (35.5%)	<0.001
1	14 (15.2%)	125,244 (22.2%)		23 (18.9%)	125,244 (12.2%)	
2	26 (28.3%)	48,657 (8.6%)		30 (24.6%)	48,657 (4.7%)	
3	15 (16.3%)	15,241 (2.7%)		23 (18.9%)	15,241 (1.5%)	
4	8 (8.7%)	4784 (0.8%)		14 (11.5%)	4784 (0.5%)	
≥5	1 (1.1%)	43,700 (0.8%)		4 (3.3%)	4370 (0.4%)	
Termination of pregnancy 0 ≥ 1	76 (82.6%)	493,508 (87.4%)	0.163	100 82.0%)	493,508 48.0%)	0.084
	16 (17.4%)	70,939 (12.6%)		22 18.0%)	70,939 6.9%)	
Miscarriage 0	68 (73.9%)	466,383 (82.6%)	0.027	89 (73.0%)	466,383 (45.3%)	0.115
≥1	24 (26.1%)	98,064 (17.4%)		33 (27.0%)	98,064 (9.5%)	
Visits in maternity clinics visits** (SD)	16.6 (5.4)	16.2 (5.4)	0.466	16.1 (5.3)	16.5 (5.3)	0.821
Outpatient clinic visits in hospital (SD)	5.5 (4.4)	3.1 (2.7)	<0.001	5.3 (3.2)	3.1 (2.7)	<0.001

*self-reported BMI in early pregnancy. Information has been collected from Medical Birth Register since 2004.
** The Ministry of Social Affairs and Health is responsible for guiding the development of maternity and child health clinics. Municipalities are in charge of the practical arrangement of services.
Parity 0= no previous births.

Nonbariatric group

The nonbariatric group comprised 66 women (71.7%) with 89 deliveries altogether. Sixty-four (97.0%) of first deliveries after LBCS were singleton births. The mean latency between LBCS and delivery was 4.41 years (range: 0.63-13.02 years; Figure 1). The mean age was 33.2 years and the mean early pregnancy BMI was 27.2 years. We recorded 56 (84.8%) abdominoplasty procedures, 6 (9.1%) body lifts, and 4 (6.1%) other esthetic corrections on the skin of the trunk in this group. According to records 59.1% of procedures were done in public hospitals and the remainder in private hospitals.

There were 14 (21.2%) women with at least one previous termination of pregnancy and 16 (24.2%) with at least one previous miscarriage.

The mean length of pregnancy was 275.4 days (SD 14.9). Low birth weight (< 2500 g) was recorded in three (4.5%) deliveries. Six (9.1%) women had preterm delivery (<37 weeks). Forty-two births (63.6%) were vaginal deliveries and 24 (36.4%) were cesarean sections. In total, 14 (21.2%) planned, 8 (12.1%) urgent, and 2 (3.0%) emergency sections were recorded. In all, 21.2% had no prior births, 15.2% had one previous birth, 31.8% had 2 births, 19.7% had 3 births, 10.6% had 4 births, and 1.5% had 5 or more prior births in this group.

Comparison of the bariatric and nonbariatric groups

The statistical analysis showed the bariatric and nonbariatric cohorts had undergone similar types of LBCS (abdominoplasty, $P = .339$ and body lift, $P = .722$) and had similar rates of previous termination of pregnancy ($P = .148$) and miscarriage ($P = .872$). There were no statistical differences for the length of pregnancy ($P = .301$) and number

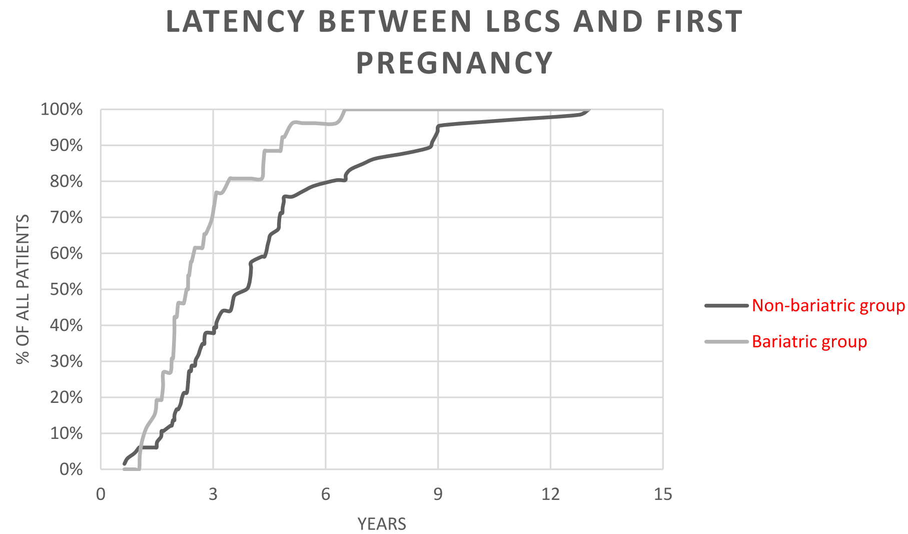

Figure 1 Latency (years) between LBCS and first delivery.

of low birth weight babies ($P = .065$) or preterm deliveries ($P = .893$).

There were significant statistical differences for mean age ($P = .025$), mean BMI in early pregnancy ($P < .001$), and parity ($P = .006$). LBCS was performed in a public hospital more often in the bariatric group ($P = .005$). Table 3 summarizes the demographic data of the bariatric and nonbariatric groups.

Predelivery diagnosis

In Table 4, we present the most common obstetric predelivery diagnoses for the bariatric and nonbariatric groups. Gestational diabetes mellitus (GDM, ICD-10 code O24.4) was more common in the nonbariatric group when compared with the bariatric group (18 [54.5%] vs. 2 [2.2%], respectively; $P < .001$). Excessive fetal growth (ICD-10 code O36.6) associated with GDM was only recorded in the nonbariatric group (9 [27.3%] and $P < .001$). Fear of childbirth (ICD-10 code O99.8) was more prevalent in the nonbariatric group than in the bariatric group (5 [15.2%]) vs. 3 [3.4%], respectively; $P = .02$). Uterine scarring from previous surgery (ICD-10 code O34.2) was more prevalent in the nonbariatric surgery group (25 [75.8%] vs. 5 [5.6%], respectively; $P < .001$).

There is no definitive diagnosis code for rectus diastasis, and empirically we know that in Finland, the “Ventral hernia without obstruction or gangrene (K43.9)” is used when addressing the rectus diastasis. In the nonbariatric group patients, the “Ventral hernia without obstruction or gangrene” diagnosis was more common compared with bariatric group, and in both circumstances, first delivery after LBCS and all deliveries after LBCS the difference reached statistical significance, p=.023 and p=.019, respectively.

Risk factors analyses

Table 5 shows the results of univariate statistical analysis for the potential risk for low birth weight, preterm delivery, or cesarean section, evaluated with risk factors such as latency between LBCS and delivery, maternal age, parity, mean BMI in early pregnancy, and preceding bariatric operations.

In short, the background-adjusted risk for cesarean section in the nonbariatric group was 2.64; 95% CI, 1.58-4.40. The risk for preterm delivery (<37 weeks) in the nonbariatric group was adjusted 2.20; 95% CI 1.01-4.79. The risk for low birth weight (<2500 g) in the bariatric group was adjusted OR 4.30; 95% CI 1.50-12.31. All other variables failed to predict an increased risk for low birth weight, pre-term delivery, or cesarean section.

Discussion

We reviewed the national registry data for women who became pregnant after LBCS during 1999-2016 in Finland. We aimed to answer the question of whether pregnancy after LBCS is safe for the mother and the baby. Overall, plans for future pregnancy are considered a relative contraindication for abdominoplasty, and patients are often advised to have children before undergoing LBCS. Further, there seems to be no guidelines, treatment recommendations, or even data on the outcome for the mother or the baby for patients who become pregnant after LBCS.

Weight loss and pregnancy are two common etiologies leading to functional and esthetic problems in the lower body in women. In this study, we divided the women who had undergone LBCS before pregnancy into two groups: those who had undergone a preceding bariatric operation and those who had not. Our main finding is that pregnancy and delivery is safe for the mother and the baby after LBCS. During our study period, we did not record any maternal or infant mortality.

We found that even though the length of pregnancy is shorter among women with preceding LBSC ($P = .009$), these pregnancies do, however, proceed to term and the mean length is only shorter by 3.6 days. These patients typically had more outpatient clinic visits in hospital during pregnancy ($P < .001$), when compared with all pregnancies

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Table 3 Demographic characteristics of the first pregnancies and delivery after LBCS in Finland 1999–2016. The p values denote the statistically significant correlations between the groups with and without preceding bariatric procedure.

	Bariatric group	Nonbariatric group	p-value
n	26	66	
Mean age (SD)	35.9 (5.3)	33.2 (4.9)	0.025
Mean BMI* (SD)	32.0 (4.7)	27.2 (4.9)	<0.001
Bariatric surgery			
Gastroplasty (JDF01)	1 (3.8%)	-	0.109
Gastric bypass (JDF11)	22 (84.6%)	-	<0.001
Other	3 (11.5%)	-	0.005
Lower body contouring surgery Abdominoplasty (QBJ30)			
Body lift (QBJ05)	23 (88.5%)	56 (84.8%)	0.339
Other esthetic correction on the skin of trunk (QBJ99)	3 (11.5%)	6 (9.1%)	0.722
Other esthetic correction trunk (QBJ99)	0 (0%)	4 (6.1%)	0.199
Hospital, where LBSC were done			0.005
In public hospital	24 (92.3%)	39 (59.1%)	
In private hospital	2 (7.7%)	27 (40.9%)	
Mean length of pregnancy, days (SD)	271.2 (18.3)	275.4 (14.9)	0.301
Singleton	26 (100%)	64 (97.0%)	0.443
Low birth weight, (<2500 g)	4(15.4%)	3 (4.5%)	0.065
Preterm delivery (<37 weeks)	2 (7.7%)	6 (9.1%)	0.893
Postterm delivery (>42 weeks)	0	0	NA
Vaginal delivery	18 (69.2%)	42 (63.6%)	0.470
Cesarean section	8 (30.8%)	24 (36.4%)	
Planned	5 (19.2%)	14 (21.2%)	0.938
Urgent	3 (11.5%)	8 (12.1%)	0.986
Emergency	0	2 (3.0%)	0.385
Parity 0	14 (53.8%)	14 (21.2%)	0.006
1	4 (15.4%)	10 (15.2%)	
2	5 (19.2%)	21 (31.8%)	
3	2 (7.7%)	13 (19.7%)	
4	1 (3.8%)	7 (10.6%)	
≥5	0	1 (1.5%)	
Termination of pregnancy 0	24 (92.3%)	52 (78.8%)	0.148
≥1	2 (7.7%)	14 (21.2%)	
Miscarriage 0	18 (68.2%)	50 (75.8%)	0.872
≥1	8 (30.8%)	16 (24.2%)	
Visits in maternity clinics** (SD)	16.3 (6.0)	16.7 (5.3)	0.744
Outpatient visits in hospital during pregnancy (SD)	6.4 (4.0)	5.1 (4.5)	0.167

*self-reported BMI in early pregnancy. Information has been collected from Medical Birth Register since 2004.
** The Ministry of Social Affairs and Health is responsible for guiding the development of maternity and child health clinics. Municipalities are in charge of the practical arrangement of services.

and deliveries in Finland during the same study time. Although we found a significantly higher percentage of low birth weight babies (<2500 g) in the LBCS group (7.4%) as compared to total births in Finland (4.5%), this association did not prove to be statistically significant.

Focusing on the first pregnancies and deliveries after LBCS, we verified that these pregnancies proceed to term, even though the length of pregnancy is shorter ($P = .019$) and there is an overrepresentation of preterm deliveries (<37 weeks) ($P < .001$). These preterm deliveries occur near term (late- preterm), because no difference is detected in the number of low birth weight newborns. The outpatient clinic visits in hospital during pregnancy are numerous. The overrepresentation of preterm deliveries might be explained by maternal demographics rather than association with LBCS. As this current study is observational, we cannot provide clear rationale for this finding and we suggest that further studies should focus on this finding. Again, we recorded overrepresentation of low birth weight babies in the LBCS group, 7.6% vs. 4.4%, with no statistical significance. Furthermore, the mothers in the LBCS group were heavier and older ($P < .001$) and they also had more miscarriages ($P = .027$). According to the previous studies,[25,26] both the BMI and age are important and independent risk factors for miscarriages, so this could be an explanation for a higher rate of miscarriages.

In this study, we found that the latency between LBCS and delivery did not have any effect on the risk for low birth weight, preterm delivery, or cesarean sections. Despite our efforts, we could not provide a cut-off point for latency

Table 4 The most common predelivery diagnosis and ICD-10 codes.

Predelivery diagnosis (ICD-10 codes)	The first delivery after LBCS			All deliveries after LBCS		
	Bariatric group	Nonbariatric group	p-value	Bariatric group	Nonbariatric group	p-value
Preexisting essential hypertension (O10.0)	0 (0.0%)	1 (1.5%)	0.528	0 (0.0%)	1 (1.1%)	0.541
Hypertension gravidarum (O13)	3 (4.5%)	3 (11.5%)	0.221	5 (5.6%)	4 (12.1%)	0.222
Preeclampsia, unspecified (O14.9)	0 (0.0%	1 (3.0%)	0.099	0 (0.0%)	1 (3.8%)	0.109
Gestational diabetes mellitus (O24.4)	2 (3.0%)	16 (61.5%)	<0.001*	2 (2.2%)	18 (54.5%)	<0.001*
Maternal care for excessive fetal growth (O36.6)	0 (0.0%)	8 (30.8%)	<0.001*	0 (0.0%)	9 (27.3%)	<0.001*
Polyhydramnios (O40.0)	0 (0.0%)	4 (15.4%)	0.001*	0 (0.0%)	4 (12.1%)	0.001*
Fetal distress during labor (O68.0)	3 (4.5%)	3 (11.5%)	0.221	4 (4.5%)	3 (9.1%)	0.332
Mental disorders and diseases of the nervous system complicating pregnancy, childbirth and the puerperium (O99.3)	1 (1.5%)	1 (3.8%)	0.490	1 (1.1%)	1 (3.0%)	0.461
Fear of childbirth (O99.8)	3 (4.5%)	4 (15.4%)	0.077	3 (3.4%)	5 (15.2%)	0.020*
Ventral hernia without obstruction or gangrene (K43.9)	0 (0.0%)	2 (7.7%)	0.023*	0 (0.0%)	2 (6.1%)	0.019*
Maternal care due to uterine scar from previous surgery (O34.2)	5 (7.6%)	22 (84.6%)	<0.001*	5 (5.6%)	25 (75.8%)	<0.001*

*statistically significant difference.

Table 5 Risk factors for cesarean section, Preterm delivery (<37 weeks) and Low birth weight (<2500 g) when compared with all deliveries ($n = 1,028,503$) in Finland during 1999-2016.

Odds Ratio Estimates and Wald Confidence Intervals

Cesarean section			Preterm delivery (<37 weeks)			Low birth weight (<2500 g)		
Study Variable	OR	95% Cl	Study Variables	OR	95% Cl	Study variables	OR	95% Cl
Year between LBCS and delivery	0.992	(0.990-0.993)	Year between LBCS and delivery	1.003	(0.999- 1.006)	Year between LBCS and delivery	1.001	(0.997-1.005)
Maternal age	1.071	(1.070-1.073)	Maternal age	1.017	(1.015-1.019)	Maternal age	1.021	(1.019-1.024)
Parity	0.682	(0.677-0.687)	Parity	0.919	(0.909-0.929)	Parity	0.847	(0.835-0.858)
BMI*	1.056	(1.055-1.058)	BMI *	1.012	(1.010-1.014)	BMI*	0.993	(0.990-0.996)
Bariatric group	0.939	(0.425-2.076)	Bariatric group	1.190	(0.284-4.990)	Bariatric group	4.298	(1.500-12.312)
Nonbariatric group	2.637	(1.580-4.401)	Nonbariatric group	2.197	(1.009-4.785)	Nonbariatric group	1.990	(0.726-5.456)

*Self-reported Body Mass Index (BMI) in early pregnancy.

between LBCS and pregnancy. Abdominoplasty is notoriously prone to postoperative complications [27,28] and when wound healing and scar maturation are orderly, cicatrization is usually finished after one year.[29] Therefore, based on the physiology of wound healing, we recommend a latency of 12 months after LBCS. Regarding rectus plication and pregnancy, the significant stretching of the abdominal wall takes place during the last two trimesters and during the first trimester, stretching and expansion is minimal. Usually, a minimum of three months after rectus plication operation any core exercises are allowed as midline rectus plication scar improves over time.

We recorded a significant difference in planned cesarean sections in the LBCS group as compared to all deliveries in Finland during the study period (16.4% vs. 6.8% and $P < .001$). A subgroup analysis revealed a high incidence of fear of childbirth and an extremely high incidence of previous cesarean sections. One additional reason may be that the previous LBCS may create a fear or worry in the obstetricians. In this study, as mentioned further, gestational diabetes and macrosomia were significantly more common in the nonbariatric group. Also, these women had more previous cesarean sections. These are all important and independent indications for cesarean sections, and presumably explain the increased proportion of planned cesarean sections. The higher incidence of fear of childbirth includes operations on maternal request, which have no ICD-code in Finland. However, we found no significant difference in urgent cesarean sections ($P = .017$) and in emergency cesarean sections ($P = .321$). This finding suggests that previous LBCS is not a contraindication for vaginal delivery, and vaginal delivery is safe for this patient population. In previous studies, cesarean section rates increased after bariatric surgery.[9,30,31] This finding may have resulted from differences in the control populations studied. In general, in concluded studies there was an increased risk for cesarean delivery, when deliveries for bariatric mothers were compared with deliveries from an unmatched general population or a normal-weight population.

Pregnancy after bariatric surgery is a very actively studied topic.[3,4,30] This is probably because bariatric surgery has become more common due to an increase in the number of obese women of fertile age; almost half of bariatric patients are women of reproductive age.[32] The positive impact of bariatric surgery on female reproduction has also been confirmed.[7] A systemic review and meta-analysis showed that bariatric surgery is associated with a 28% increase in preterm delivery.[31] On the other hand, the same study did not demonstrate any significant difference in cesarean section rates in women after bariatric surgery. Nutritional disorders resulting from bariatric surgery have been shown to affect fetal growth, and to cause an increased incidence of babies who are small for gestational age.[3,30] Again, the bariatric surgery is associated with decreased incidence of gestational diabetes.[33,34] We calculated and found significantly more cases of gestational diabetes in the nonbariatric than bariatric group ($P < .001$) (Table 4). Bariatric surgery procedures are most commonly laparoscopic with limited incisions and thus they do not alter the abdominal wall. Therefore, the issues with pregnancies and babies are more related to nutritional issues.

In line with previous studies on the health benefits of bariatric surgery, in the analysis of the predelivery diagnosis, we found that gestational diabetes and excessive fetal growth cumulated in the nonbariatric group, even though the early pregnancy BMI was statistically significantly higher in the bariatric group. Women are advised to have a latency of at least 12 months, but preferably 2 years before pregnancy after bariatric surgery.[35] The first 12 - 16 months after bariatric surgery are a time of rapid weight loss and metabolic changes that can potentially result in nutritional deficiencies.[36,37]

One of the fears regarding pregnancy after LBCS and abdominoplasty has been that the reduced flexibility of the abdominal wall may endanger the health of both mother and child. To the best of our knowledge, only four published articles address this topic, and most are case reports. In 1996, Menz [23] published a case report introducing a 37-year-old woman who had an abdominoplasty with rectus plication. Already with three children, she no longer wished to have more. However, three years later she became pregnant and was told by her surgeon that midline sutures may cause problems during the pregnancy. Following that advice, she chose to have the pregnancy terminated. A few years later she sought another opinion regarding the possibility of pregnancy following abdominoplasty. She was advised by Menz that this should be possible, but the pregnancy would need to be monitored closely. Eventually, 5 years after abdominoplasty, she completed a pregnancy and gave birth to a normal infant by elected cesarean section. This case ended happily, but due to a lack of knowledge, the woman was recommended a termination of pregnancy due to abdominoplasty. A further issue for pregnancy after LBCS is that pregnancy may destroy the esthetic result of the operation. Pregnancy involves a slow and progressive tissue expansion,[21] and muscles are contractile tissues and tend to return to their original condition after pregnancy. An alternative body contouring procedure for fertile age women is liposuction of abdomen that does not alter the abdominal muscle wall or significantly alter the elasticity of the skin fat envelope that may cause issues during subsequent pregnancy.

This current register-based study might be limited in the validity of the National Hospital Discharge.[38] Recording of secondary operations and other rarely used items are the most obvious, but this does not compromise the value of data in this register in being used in studies that are otherwise not feasible to conduct. Therefore, technical incompleteness does not cause bias in the results.

Rectus plication for muscle divarication in conjunction with LBCS may affect elasticity of the abdominal musculature during pregnancy. Another shortcoming is that we do not know if the rectus muscles were plicated during the abdominoplasty. There is no specific ICD-10 or NSCP code for rectus diastasis or code for the plication operation. However, in Table 4, the diagnosis, “Ventral hernia without obstruction or gangrene (K43.9)” is prevalent and statistically overrepresented in the nonbariatric group. This diagnosis is used commonly in terms of rectus diastasis. Because of a lack of specific diagnosis code, this notion remains purely speculative.

Although the correction of rectus diastasis is performed during most abdominoplasties,[39] rectus plication techniques vary from single sutures to mesh reinforcement in the midline. Therefore, in our opinion, rectus plication could not be considered as a style factor for compromising the pregnancy after LBCS.

To conclude, we verified in a large national registry-based study that pregnancy and delivery after LBCS are apparently safe for the mother and the baby. Patients of childbearing age should be informed that pregnancies after LBCS most often proceed to term, but the risk for preterm delivery and a low birth weight baby is increased, particularly after prior bariatric surgery. There is also an increased possibility of cesarean section, although, probably due to patient history. These are more likely to be planned. We also found that longer latency between the contouring operation and pregnancy does not decrease the risks.

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