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REVIEW

Clinical Practice Guidelines for Childbearing Female Candidates for Bariatric Surgery, Pregnancy, and Post-partum Management After Bariatric Surgery

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Abstract

Emerging evidence suggests that bariatric surgery improves pregnancy outcomes of women with obesity by reducing the rates of gestational diabetes, pregnancy-induced hypertension, and macrosomia. However, it is associated with an increased risk of a small-for-gestational-age fetus and prematurity. Based on the work of a multidisciplinary task force, we propose clinical practice recommendations for pregnancy management following bariatric surgery. They are derived from a comprehensive review of the literature, existing guidelines, and expert opinion covering the preferred type of surgery for women of childbearing age, timing between surgery and pregnancy, contraception, systematic nutritional support and management of nutritional deficiencies, screening and management of gestational diabetes, weight gain during pregnancy, gastric banding management, surgical emergencies, obstetrical management, and specific care in the postpartum period and for newborns.

Keywords Pregnancy · Bariatric surgery · Obstetrical management · Nutritional management · Guidelines

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Introduction

Bariatric surgery (BS) is increasingly performed worldwide on patients with severe obesity [1], mostly women. Most of these women are of childbearing age [2, 3], and thus an increase in the number of pregnancies after BS is expected. Emerging evidence suggests that BS improves pregnancy outcomes of women with obesity by reducing the rates of gestational diabetes, pregnancy-induced hypertension, and macrosomia. However, the risks of a small-for-gestational-age (SGA) fetus and prematurity are increased [4]. Existing clinical guidelines emphasize the need to plan pregnancy and raise awareness concerning the risks of surgical complications and nutritional deficiencies but report several areas without specific recommendation due to lack of evidence [5–14]. Nevertheless, practical and comprehensive guidelines are needed for practitioners to cover the various issues related to pregnancy management in this context. The aim of our multidisciplinary working group was to analyze the current literature on pregnancy after BS and propose guidelines for practitioners to improve routine care and avoid occurrence of rare but dramatic complications. We report the process followed by the working group and summarize the guidelines concerning childbearing candidates for BS, pregnancy, and post-partum management after BS.

Protocol

We defined the questions to be addressed by performing a survey of the routine care provided by specialized obesity-care centers (Centres Spécialisés Obésité or CSO, the tertiary care level in the French healthcare system identified by the Regional Health Agencies following the launch of a national obesity plan in 2011) [15]. We identified 12 main topics: preferred type of surgery for women of childbearing age, timing between BS and pregnancy, contraception after BS, specific nutritional support and management of nutritional deficiencies, modalities for screening and treatment of gestational diabetes, weight gain during pregnancy, gastric banding management, surgical emergencies, obstetrical management, management during the postpartum period and for newborns, and the overall care pathway.

We developed the guidelines following the protocol designed by the French National Authority for Health (Haute Autorité de Santé, HAS, a national institute which performs tasks similar to the UK National Institute for Health and Care Excellence, NICE) as published on its website [16]. This methodology includes (1) a comprehensive literature search, (2) a series of workshops attended by members of the working group (three meetings for the present guidelines), and (3) an amendment of the guidelines considering the opinions expressed by a large multidisciplinary reading group (109 individuals were involved) obtained through a critical reading.

The literature search was performed until May 2019 using four electronic databases (PubMed, Web of Science, Cochrane Library, and National Guideline Clearinghouse (Agency for Healthcare Research and Quality)). Recommendations were graded from A to C depending on the level of evidence provided by the reviewed studies (Table 1 of supplementary data). When no study was available, recommendations were based on expert opinion. Our multidisciplinary task force included general and bariatric surgeons, physicians with a specialty in nutrition, diabetologists, gynecologists and obstetricians, pediatricians, clinical biologists, and representatives of associations of patients with obesity and was supported by all relevant French scientific societies related to obesity (AFERO, Association Française d'Etude et de Recherche sur l'Obésité), bariatric surgery (SOFFCO.MM, Société Française et Francophone de Chirurgie de l'Obésité et des Maladies Métaboliques), obstetrics and gynecology (CNGOF, Collège National des Gynécologues et Obstétriciens Français), nutrition (SFNCM, Société Francophone de Nutrition Clinique et Métabolisme), pediatrics (SFN, Société Française de Néonatalogie; SFP, Société Française de Pédiatrie), diabetology (SFD, Société Francophone du Diabète), and the national coordination and consultation group of specialized obesity treatment centers.

Recommendations

All recommendations have been graded from A to C, as indicated above; when not graded, they represent expert opinions.

Obstetrical Management and Clinical Care Pathway

The risk of a SGA fetus and prematurity increase following BS [4, 17, 18]. Thus, reliable dating of pregnancies is important, relying on an early dating ultrasound (at a theoretical gestational age of approximately 8 to 10 weeks) if the menstrual cycle is irregular. Pregnant women should have a standard monthly antenatal medical appointment, which is standard recommended practice in countries such as France [19] (grade B). A closer prenatal surveillance is required in settings where monthly visits are not standard practice. This antenatal care should be coordinated by an obstetrician and include measurement of fundal height at each visit and an additional ultrasound examination during the third trimester to screen for SGA. In the case of clinical and/or ultrasound suspicion of SGA or additional risk factors of SGA, evaluation and surveillance should be adapted as per specific guidelines [20].

A multidisciplinary antenatal approach is recommended and should include competent surgical advice if there is a suspicion of surgical complications. Pregnant women with a history of BS must inform the obstetrical team.

Type of Surgery to Propose to Women of Childbearing Age with Obesity

There is no scientific evidence yet available to guide the choice of the most appropriate surgical procedure for women of childbearing age. Women should be informed of the risks of surgical complications after procedures involving the small intestine, such as Roux-en-Y gastric bypass (GBP), as well as after adjustable gastric banding (AGB), and the higher frequency of SGA and nutritional deficiencies after GBP [17, 21, 22] and biliopancreatic diversion (BPD) [23, 24] (grade C). Available data on pregnancy after sleeve gastrectomy are insufficient to recommend this intervention over others [23, 25–27] (grade C). An indication of omega-loop GBP, single anastomosis duodenoileal bypass (SADI), or BPD should be considered with caution, given the nutritional deficiencies and cases of undernutrition associated with these procedures [28, 29] (grade C).

Timing of Pregnancy After Bariatric Surgery

A minimal interval of 12 months between BS and pregnancy is recommended to allow the weight of the patient to stabilize [5–7, 10, 11, 13, 14, 30, 31] (grade C). Special attention is required if surgery occurred many years earlier, as loss to follow-up and nutritional deficiencies are likely [32] (grade C) or if the pregnancy begins less than 12 months after surgery, as this would require reinforced nutritional and obstetric monitoring. A shorter interval can be considered in cases of advanced maternal age or reduced ovarian reserve [9, 33, 34] (grade C), but must be balanced against the risk of nutritional deficiencies and residual obesity-related comorbidities.

Contraception After Bariatric Surgery

Contraception must be started prior to surgery [6, 9, 14]. All contraceptives (hormonal and intrauterine devices) are effective in women with obesity [35] (grade B). Nevertheless, long-acting reversible contraceptives (etonogestrel implants and intrauterine devices) appear to be the best options before and after BS [6, 7, 9, 36, 37] (grade C).

If the prescription of long-acting reversible contraception is not chosen, the following elements must be considered when prescribing an oral contraceptive:

- Increased risk of venous thromboembolism and arterial thrombosis related to combined oral contraceptives. Such a risk requires discontinuation of combined oral contraceptives at least 4 to 6 weeks before, and at least 6 weeks after surgery, and substitution by another contraceptive method [37, 38] (grade C).
- Increased risk of contraceptive failure if there are digestive disorders (vomiting, diarrhea) [39, 40]
- The type of surgical procedure:
  - For AGB and sleeve gastrectomy, oral contraceptives can be used without a theoretical risk of failure, unless there is vomiting or diarrhea [40] (grade C).
  - For Roux-en-Y GBP, there is a low level of evidence concerning the effectiveness of such contraceptive methods [41–46] (grade C).
  - For BPD [14, 47] (grade C), SADI, and omega-loop GBP, oral contraception is contraindicated due to significant theoretical malabsorption of such compounds.

Nutritional Management

Women should ideally have a consultation before conception, or as soon as pregnancy is diagnosed, with a physician with expertise in the management of bariatric-surgery patients [14, 48].

Systematic Minimal Nutritional Supplementation

When planning a pregnancy, regardless of the type of surgery*, systematic supplementation should include daily multivitamins containing trace elements with at least 10 mg zinc and 1 mg copper, and no more than 5000 IU vitamin A, preferably in the form of beta carotene [5, 6, 13]. In addition, daily intake of 0.4 mg folic acid is recommended (grade A), with a maximum of 1 mg per day (5 mg per day if there is a history of neural-tube defects) [7, 8, 19].

During pregnancy, the following supplementation is recommended, regardless of the type of surgery *:

- If there is regular nutritional monitoring:
  - Adapt the multivitamins as described above, if necessary
  - Add folic acid up to 12 weeks gestation [19] (grade A)
  - Continue the usual supplementation (if compatible with pregnancy)

- In the absence of a biological assay during the previous year or in the absence of correction of known deficiencies:
  - Add or adapt multivitamins as described above
  - Add folic acid up to 12 weeks gestation
  - Add systematic supplements at the minimal dose without waiting for the results of the assays: 50 to 80 mg iron per day and 1000 μg vitamin B12 once a week, orally

It is recommended to systematically refer the patient to a registered dietitian to assess energy and protein

intake [13]. The recommended daily protein intake should be at least 60 g [5, 6, 49]. If necessary, prescription of oral protein supplements can be an option [23, 25, 50].

*For BPD and other similar procedures, pregnancy must be followed by a physician with expertise in clinical nutrition who is familiar with such procedures that result in malabsorption, because larger doses of supplements are often required.

Table 1 Recommended testing before and during pregnancy for all types of surgery

	Preconception and as soon as the woman is pregnant	At least every trimester of pregnancy	In case of
Hemogram	X	X	
Ferritin	X	X	
Transferrin saturation	X	X	
Albumin	X	X	
Transthyretin or prealbumin	X	X	
25 OH vitamin D	X	X	
Parathyroid hormone	X	X	
Calcium	X	X	
Phosphorus	X	X	
Serum and erythrocyte folates	X	X	
Vitamin B12	X	X	
Prothrombin time	X	X	
Magnesium	X	X	
Zinc	X	X	
Vitamin B1	X		- Repeated vomiting (emergency) - Initial deficiency
Vitamin A	X		- At each trimester of pregnancy in case of Bypass and other derivations - Initial deficiency
Selenium	X		- Initial deficiency
Copper and ceruloplasmin			- Anemia refractory to iron supplementation - Multiple and severe deficiencies
Vitamin K			- Bleeding - Multiple and severe deficiencies
Vitamin PP			- Pellagra, neurological disorders - Multiple and severe deficiencies
Vitamin B6			- Neurological disorders - Multiple and severe deficiencies
Vitamin C			- Scurvy, anemia refractory to iron supplementation - Multiple and severe deficiencies
Vitamin E			- Anemia, ophthalmoplegia - Peripheral neuropathy

Table 2 Usual observed values of biological assays performed in general healthy pregnant women

Micronutrient marker	Country of the study	Data are 2.5th–97.5th percentile, unless otherwise stated				Conversion for usual units
		General population	First trimester	Second trimester	Third trimester	
Albumin (g/L)	Germany [57][d]	36.5–47.9	7–17 GW: 32.2–43.2	17–24 GW: 27.9–36.9	23.1–34.6	
	Norway [66][m]	nd	nd	36.7 ± 2.0	33.8 ± 1.9	
	Various [53]	*R*: 41–53	*R*: 31–51	*R*: 26–45	*R*: 23–42	
Prealbumin (mg/dL)	Various [53]	*R*: 17–34	*R*: 15–27	*R*: 20–27	*R*: 14–23	
Retinol (μmol/L)	France [58][e]	1.4–50	0.66–1.92	nd	0.52–1.78	1 μmol/L = 286 ng/mL
	Various [53]	*R*: 0.7–3.49	*R*: 1.12–1.64	*R*: 1.22–1.54	*R*: 1.01–1.47	1 ng/mL = 1.67 IU/L
B carotene (μmol/L)	France [58][e]	0.1–0.6	< 0.85	nd	< 0.84	1 μmol/L = 537.63 ng/mL
Vitamin B1 (nmol/L)	Great Britain [59][f]	Threshold: < 66.5	40.4–159.6	nd	16.57–160.83	1 nmol/L = 0.337 ng/mL
Vitamin B6 (nmol/L)	Brazil [60][g]	nd	Med: 35.8 [28.6–44.3]	Med: 21.0 [15.8–26.3]	Med:16.8 [12.9–20.3]	1 nmol/L = 0.247 ng/mL
Plasma folate (ng/mL)	France [58][e]	3–17	0.79–12.23	nd	< 13.65	1 nmol/L = 0.44 ng/mL
	Denmark [54][a]	nd	2.64–14.96	2.2–9.68	1.76–9.68	
	Various [53]	*R*: 5.4–18.0	*R*: 2.6–15.0	*R*: 0.8–24.0	*R*: 1.4–20.7	
Erythrocyte folate (ng/mL)	France [58][e]	175–700	105–827	nd	30–1022	1 nmol/L = 0.44 ng/mL
	Various [53]	*R*: 150–450	*R*: 137–589	*R*: 94–828	*R*: 109–663	
Vitamin B12 (pg/mL)	France [58][e]	200–950	51–549	nd	36–400	1 pmol/L = 1355.36 pg/L
	Denmark [54][a]	nd	70.8–357.1	53.9–86.3	52.4–245.7	
	Germany [55][b]	nd	CI 95%: 166.7–395.8	CI 95%: 156.5–59.6	CI 95%: 118.8–146.1	
	Various [53]	*R*: 276–966	*R*: 118–438	*R*: 130–656	*R*: 99–526	
Vitamin E (μmol/L)	France [58][e]	12–48	17.68–36.50	nd	22.21–49.25	1 μmol/L = 430.69 ng/mL
	Various [53]	*R*: 11.61–41.79	*R*: 16.25–30.18	*R*: 23.22–37.15	*R*: 30.18–53.4	
25-OH vitamin D (nmol/L)	USA [61][h]		Med: 65.0 (SD: 23.5) (winter 57.5; spring 63.8; autumn 67.5; summer 70)			1 nmol/L = 0.40 ng/mL
	Great Britain [59][f]	Threshold: < 50	Med: 37.5 [Q1:26–Q3:48.8]	Med: 37 [Q1:15.3–Q3: 60.8]	Med: 56.5 [Q1: 34–Q3: 80.5]	
	Swiss [62][i]	nd	nd	nd	Med: 46.0 [Q1: 30.5–Q3: 68.5]	
	Various [53]	*R*: 35–200	*R*: 45–67.5	*R*: 25–55	*R*: 25–45	
Parathyroid hormone (pmol/L)	USA [61][h]	nd	Med: 1.2 (winter 1.59; spring 1.22; autumn 1.11; summer 1.07)	nd	nd	1 pg/mL = 1 ng/L = 0.106 pmol/L
	USA [63][j]	1.3–5.4	1.9 ± 1.0	1.9 ± 1.0	2.2 ± 1.3	
	Ireland [64][k]	nd	nd	Mean (CI 95%): 0.98 (0.89–1.08)	nd	
	Various [53]	*R*: 0.85–5.41	*R*: 1.06–1.59	*R*: 1.91–2.65	*R*: 0.95–2.76	
Calcium (mmol/L)	France [58][e]	2.25–2.62	1.92–2.74	nd	1.57–2.63	1 mmol/L = 40 mg/L
	Various [53]	*R*: 2.18–2.55	*R*: 2.2–2.65	*R*: 2.05–2.25	*R*: 2.05–2.43	

Table 2 (continued)

Micronutrient marker	Country of the study	Data are 2.5th–97.5th percentile, unless otherwise stated				Conversion for usual units
		General population	First trimester	Second trimester	Third trimester	
Copper (μmol/L)	France [58][e]	12.9–25.3	16.4–36.3	nd	17.9–43.4	1 μmol/L = 63.5 ng/mL
	Spain [56][c]	nd	12.55–33.92	23.62–38.47	19.94–41.53	
	Various [53]	*R*: 11.0–22.0	*R*: 17.6–31.3	*R*: 26.0–34.8	*R*: 20.5–37.8	
Ferritin (μg/L)	Great Britain [59][f]	Threshold: < 15	Med: 42.5 [Q1: 27–Q3: 74.3]	Med: 10.5 [Q1:7–Q3: 20.8]	Med: 9 [Q1: 7–Q3: 15.3]	1 nmol/L = 445 ng/mL
	Denmark [54][a]	nd	8–123	6–48	7–64	
	Germany [57][d]	10–90	7.1–106.4	4.1–65.6	3.8–49.8	
	Various [53]	*R*: 10–50	*R*: 6–130	*R*: 2–230	*R*: 0–116	
Magnesium (mmol/L)	France [58][e]	0.72–0.95	0.35–1.13	nd	0.65–0.69	1 mmol/L = 24.3 mg/L
	Germany [57][d]	0.71–0.94	0.7–0.96	0.66–0.87	0.57–0.91	
	Various [53]	*R*: 0.62–0.95	*R*: 0.66–0.91	*R*: 0.62–0.91	*R*: 0.45–0.91	
Selenium (μg/L)	Spain [56][c]	nd	69.3–147.9	51.2–146.9	55.7–118.9	1 μmol/L = 78.96 ng/mL
	Various [53]	*R*: 63–160	*R*: 116–146	*R*: 75–145	*R*: 71–133	
Zinc (μmol/L)	France [58][e]	11–16.5	6.09–13.39	nd	5.46–12.76	1 μmol/L = 65.4 ng/mL
	USA [65][l]	nd	7.7–16.3	6.2–15.6	5.4–14.0	
	Spain [56][c]	nd	7–14.77	6.76–11.93	6.13–12.14	
	Various [53]	*R*: 11.47–18.4	*R*: 8.72–13.46	*R*: 7.8–12.23	7.64–11.77	

GB Great Britain, *GW* gestational week, *Med* median, *nd* no data, *Q* quartile, *R* range (minimum-maximum combined with 2.5–97.5th percentiles if available)

[a] [54] 434 women, 30 ± 3.9 years, mean BMI: 24 ± 3 kg/m^2

[b] [55] 39 women, 29.1 ± 3.6 years, mean BMI: 23.1 ± 4.7 kg/m^2

[c] [56] 159 women

[d] [57] 52 women, median age: 32 years (SD: 4 years), median BMI: 24 kg/m^2 (SD: 4 kg/m^2)

[e] [58] 50 women, 28 ± 4.5 years, mean BMI 22.8 ± 6.9 kg/m^2

[f] [59] 189 women, 27.9 ± 6.2 years; median BMI 24.7 kg/m^2

[g] [60] 186 women, 20–40 years

[h] [61] 586 Caucasian women, mean age: 32.3 years, BMI: nd

[i] [62] 305 women, 32.9 ± 5.2 years, median BMI: 22.9 kg/m^2

[j] [63] 111 women, 27 ± 5.6 years, 78 with BMI < 30 kg/m^2, 33 with BMI > 30 kg/m^2

[k] [64] 142 women, 33.4 ± 3.8 years, BMI 25.8 ± 4.3 kg/m^2

[l] [65] 3,742 women < 34 GW, 85% Afro-American, 15% white American

[m] [66] 853 women, 30.5 ± 4.3 years, BMI: nd

Nutritional Assessment and Supplementation in the Case of Nutritional Deficiency

We recommend adapting systematic nutritional supplementation based on deficiencies identified during the initial nutritional assessment (Table 1), which needs to be repeated quarterly [6, 51, 52].

During pregnancy, there are no specific validated standards for the required levels of vitamins and trace elements. However, there is a 25 to 30% physiological decrease in the levels of albumin, hemoglobin, vitamins A, B9, B12, and D, parathyroid hormone (PTH), calcium, ferritin, magnesium, selenium, and zinc, whereas vitamin E, copper, and ceruloplasmin increase, and prealbumin appears to remain stable [53–66]. The usual observed values in general healthy pregnant women are summarized in Table 2 as an indication for practitioners. These usual values are issued from a comprehensive review of the literature published in 2009 [53], and a synthesis of studies published since 2010 and conducted in European and American populations [54–66] (grade C).

A prescription strategy for supplements, in the case of deficiency, is presented in Table 3 [7, 8, 25, 50, 51, 67, 77, 80, 81]. Deficiency correction should be assessed 1 month later and the substitution treatment adapted based on the subsequent quarterly biological assessment. In the case of no deficiency, next assessment is recommended during the following trimester.

Table 3 Prescription of supplements in the case of nutritional deficiency

Micronutrient marker deficiency	Dose for supplementation (based on the possible physiological decrease of micronutrient marker levels during pregnancy)
Iron [7, 8, 50, 67]	- gradually increase the oral dose up to a maximum of 240 mg iron in several intakes per day, if necessary associated with vitamin C to increase absorption.
	- respect physiological decrease in ferritin levels (high ferritin levels are also associated with small for gestational age)
	- discuss intravenous iron only if iron deficiency anemia persists, despite the maximum tolerated oral supplementation. A careful evaluation of the benefit/risk ratio is recommended before any use of injectable iron; in particular, the physiological decrease in hemoglobin levels during pregnancy (normal hemoglobin ≥ 11 g/dL for each trimester of pregnancy) must be respected
Vitamin D [25, 50, 68, 69]	- initial dose of 3000 IU per day (i.e., 100,000 IU per month), to be adjusted to blood levels of 25 OH vitamin D
Vitamin B12 [70]	- increase the frequency of oral doses (for example, 1000 μg per day for 8 days and then twice a week)
	- or 1000 μg intramuscular injection every month, or even weekly
Folates [51, 71]	- start with increasing the dose from the initial 0.4 mg per day to 0.8 mg per day to adjust blood levels of folic acid
	- a dose of greater than 0.8 mg per day may be required to correct a folic acid deficiency
Calcium [72]	- increase the dose to 1500 mg per day distant from iron intake
	- increase dietary calcium intake
	- interpretation of the results must account for the physiological decrease in parathyroid hormone during pregnancy and the correction of calcium by serum albumin
Magnesium [73]	100 to 300 mg oral magnesium per day
Zinc [73–75]	15 to 60 mg oral zinc gluconate per day, fasting in the morning or at bedtime
Selenium [76]	50 to 100 μg oral selenium per day
Vitamin B1 [51]	- urgently and systematically supplement patients who are repeatedly vomiting, without waiting for the laboratory result, with 100 to 500 mg vitamin B1 per day intravenously or intramuscularly. If it is not possible to measure blood vitamin B1 levels in vomiting patients, systematic vitamin B1 supplementation is still recommended
	- in the absence of vomiting, 250 to 500 mg oral vitamin B1 per day
Vitamin A [51, 77–79]	- start with a dose of 10,000 IU/day
	- a dose of greater than 10,000 IU/day may be required to correct a vitamin A deficiency and may be proposed after discussion within the group, depending on the evolution of blood vitamin A levels and the clinical situation

Table 4 Definition of abnormal glycaemia before and during pregnancy after bariatric surgery in comparison to general population

	General population	After bariatric surgery	
Screening conditions	Only high-risk women	All women	
Before pregnancy	* FPG	* FPG and HbA1c * Normal if FPG < 100 mg/dL and HbA1c < 6%	
Early pregnancy	* FPG * GDM if FPG ≥ 92 mg/dL	* FPG and HbA1c * GDM if FPG ≥ 92 mg/dL and/or HbA1c ≥ 5.9%	
24–28 GW (only if early pregnancy test is negative)	* 75-g OGTT * GDM if ≥ 1 value from OGTT exceed diagnosis thresholds - FPG ≥ 92 mg/dL - 1 h PG ≥ 180 mg/dL - 2 h PG ≥ 153 mg/dL	*Sleeve and AGB*: * 75-g OGTT * GDM if ≥ 1 value from OGTT exceed diagnosis thresholds - FPG ≥ 92 mg/dL - 1 h PG ≥ 180 mg/dL - 2 h PG ≥ 153 mg/dL	*OGTT not well tolerated and GBP*: * One week of CBG monitoring with usual diet and physical activity levels * GDM if ≥ 20% of all CBG exceed glycemic targets - before meals ≥ 95 mg/dL - 1 h PP ≥ 140 mg/dL - 2 h PP ≥ 120 mg/dL 1 h and 2 h PP alternately
CBG targets if GDM diagnosed	- before meals < 95 mg/dL - 2 h PP < 120 mg/dL	- before meals < 95 mg/dL - 2 h PP < 120 mg/dL In case of GBP: 1 h and 2 h PP alternately, with 1 h PP < 140 mg/dL	
Post-partum	75 g OGTT	FPG and HbA1c	

AGB adjustable gastric banding, CBG capillary blood glucose, *FPG* fasting plasma glucose, *GBP* gastric bypass, *GDM* gestational diabetes mellitus, *GW gestational weeks, OGTT* oral glucose tolerance test, *PG* plasma glucose, *PP* post prandial, 1 h one hour, 2 h two hours

Screening and Management of Gestational Diabetes Mellitus

The strategy for screening abnormal glycaemia before and during pregnancy is presented in Table 4. We consider many specificities after BS. First, women are usually still with excess weight, and at risk of abnormal glycaemia before pregnancy and of gestational diabetes mellitus (GDM) [17, 82–88] (grade C). Second, fasting plasma glucose, which decreases after BS [89–91], and HbA1c level, which is associated with an increased risk of perinatal morbi-mortality (≥ 5.9%) [92, 93], can be used during early pregnancy (grade C). Finally, 75 g-OGTT (oral glucose tolerance test) may be not well tolerated [94–96] and may induce hypoglycemia at 2 h, especially after GBP [81, 84, 96]. Therefore, a 1-week self-monitoring of capillary blood glucose with samples before each meal, and alternately 1 or 2 h after the start of each meal can be an alternative screening test after 24 weeks gestation [96, 97]. Once diagnosed, GDM should immediately be managed by lifestyle modifications, self-monitoring of blood glucose, and insulin therapy if glycemic targets are not achieved [98] (grade B).

Weight Gain During Pregnancy

No scientific evidence concerning gestational weight gain and pregnancy outcomes after BS is available. Thus, it is not possible to suggest weight-gain recommendations that would differ from those based on maternal BMI for the general population (Table 5) [6, 99, 100]. Dietary and sometimes psychological care should be reinforced if weight gain is below or above recommended targets.

Optimal Band Adjustment During Pregnancy

AGB deflation is associated with higher maternal weight gain, and thus systematic deflation is not recommended during pregnancy [101–103] (grade C). AGB inflation is not recommended either throughout pregnancy and rapid deflation is indicated if digestive symptoms appear [6, 104–106] (grade C), without X-rays. First-line radiological imaging should be performed by magnetic resonance imaging (MRI) if a complication is suspected. If not rapidly available, a computed tomography scan with digestive clouding using a water-soluble contrast product is recommended. Otherwise, an upper gastrointestinal series is recommended to urgently decide whether removal of the AGB is required.

Table 5 Recommended weight gain during pregnancy according to the IOM (Institute of Medicine) [99]

Pregestational BMI (kg/m^2)	Mean weekly weight gain during the second and third trimesters (kg)	Total recommended weight gain during pregnancy (kg)
BMI < 18.5	0.5	12.5–18
BMI from 18.5 to 24.9	0.4	11.5–16
BMI from 25.0 to 29.9	0.3	7–11.5
BMI ≥ 30	0.2	5–9

Management of a Surgical Emergency During Pregnancy

Women presenting with unusual abdominal pain and/or vomiting must be urgently assessed by a digestive surgeon, ideally with expertise in BS, because of an increased risk of intestinal obstruction (internal hernia) after Roux-en-Y GPB and AGB slippage during pregnancy [5, 6, 106–108] (grade C). In case of doubt, first-line imaging should be performed by magnetic resonance imaging (MRI) [109]. If not rapidly available, a computed tomography scan with contrast injection and digestive opacification with a water-soluble contrast product is indicated and should not be delayed due to pregnancy [110, 111]. Patient education must include clinical signs that require urgent surgical examination.

Breastfeeding and the Postpartum Period

Breastfeeding is recommended as for any woman [6, 112], as long as maternal nutritional monitoring and supplementation are performed according to the same guidelines as during pregnancy [5, 6, 14, 113, 114]. Non-steroidal anti-inflammatory drugs should be avoided in women with GBP and other types of intestinal bypass to avoid gastric ulceration [5].

Neonatal Care

We recommend informing the pediatrician about the history of maternal BS, the risks of SGA and prematurity [4, 17, 18, 48] (grade B), and the risk of nutritional deficiencies for the neonate [68]. Although cases of anemia, neurological dysfunction, hypocalcemia, bleeding, microphthalmia, and microcephaly (because of vitamin B12, B9, K, and A deficiency) have been reported [25, 51] (grade C), no routine nutritional assessment nor systematic supplementation of the newborn is recommended. There is no specific recommendation for short- and long-term monitoring of children born after BS [115–118].

Conclusion

In conclusion, an increased awareness concerning the health risks for the mother and fetus during pregnancy after BS is necessary. These clinical practice recommendations from a multidisciplinary task force provide guidance to improve patient management in this setting and for childbearing female candidates for BS. Delivering appropriate information to practitioners and to women considering pregnancy after BS, and implementing efficient clinical care pathways are needed to improve pregnancy-related outcomes. Insufficient evidence was available for a number of questions we addressed and many unresolved issues remain, such as optimal maternal nutritional care for healthy in utero programming and long-term outcomes of children born after BS. Longer-term data through large-scale cohort studies with precise phenotyping are needed to make pregnancy safer for women of childbearing age undergoing BS.

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Compliance with Ethical Standards

Conflict of Interest E.C. declares personal fees from Astra Zeneca, Lifescan, Medtronic, MSD, personal fees and non-financial support from Novartis, Novo-Nordisk, Lilly, Roche Diagnostics, Sanofi, Abbott, Orkyn, grants from Fondation Roche, Air liquide, outside the submitted work. G.R. declares personal fees from MSD laboratory Merck-Serono Laboratory, Ferring Laboratory, Teva Laboratory, outside the submitted work. All other authors declare no conflict of interest.

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