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Laparoscopic adjustable gastric banding in adolescents: Results at two years including psychosocial aspects

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ABSTRACT

Background/purpose: Obesity now affects 3%–4% of the pediatric population and contributes to the increase in cardiac mortality in adulthood. Bariatric surgery is the best treatment for weight loss and the obesity-associated comorbidities in adults. We report here our experience of laparoscopic adjustable gastric banding (LAGB) in adolescents.
Methods: The medical charts of the first 16 patients operated on in our center were reviewed. Data were compiled concerning weight loss, physical and biological comorbidities, health-related quality of life (QOL) and surgical complications before surgery and during 24 months of follow-up.
Results: The maximal pre-operative median body mass index was 43.0 $kg \cdot m^{-2}$, decreasing to 33.0 $kg \cdot m^{-2}$ at 2 years post-LAGB, which corresponded to a 49.2% excess body weight loss ($p < 0.001$). Most comorbidities (glucose intolerance, hypertension and sleep apnea) resolved within the first year post-LAGB and QOL was improved on the PedsQL™ scales. No severe surgical complications were noted, with only three re-interventions for device failure (2) or band removal (1).
Conclusion: LAGB is well tolerated in adolescents and shows a beneficial impact on weight loss and obesity-related comorbidities. Associated with global management, it may have a positive impact on patients' QOL and social and psychological status.

Obesity affects about 6.7% of the pediatric population worldwide [1]. In France, 15.8% of the pediatric population is overweight and 2.8% is obese [2]. Chronic excessive caloric intake and a sedentary lifestyle are the major culprits explaining this prevalence [2,3].

Obesity has been associated with cardiovascular, respiratory, orthopedic, endocrine and digestive complications [3,4]. It also has a significant negative psychosocial impact, especially in adolescence [5]. A severely obese teenager has more than a 70% risk of remaining so in adulthood [6], and the body mass index (BMI) in adolescence has been independently associated with the risk of coronary heart disease in the future [7,8], as well as with other associated adverse events such as diabetes, colorectal cancer and arthritis [9]. The efficacy of lifestyle interventions on weight loss has been shown to be poor [10,11]. In the last 20 years, bariatric surgery has become the treatment of choice in adult obesity and has therefore also come under consideration for adolescents. Within this context, the Teen Obesity Network-Angers was created in 2008, although obesity surgery has not yet been validated in France for teenagers with severe obesity. The purpose of the network is to propose laparoscopic adjustable gastric banding (LAGB) as a treatment for morbid obesity in adolescents 14 years old or more; all must be volunteers for the procedure, meet specific criteria, and agree to comply with the associated medical monitoring, strict nutritional management, physical reconditioning and psychological follow-up. All the adolescents undergo metabolic, digestive, cardiac, respiratory, and psychological evaluation. This study reports the results at 1 and 2 years in the first 16 patients included in the network regarding weight loss, changes in comorbidities, and improvement in quality of life. Tolerance and complications related to the placement of LAGB are also reported.

1. Material and methods

1.1. Selection of the patients and clinical survey

The data from all consecutive patients having a LAGB placed between 2008 and 2012 were prospectively collected within the

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framework of our specialized care center for severe obesity. Surgery and further clinical, metabolic, cardiorespiratory and psychological investigations were all performed in the Pediatric Department of the University Hospital of Angers. This adolescent LAGB program was approved by the local ethics committee in 2007. Patients suffering from severe obesity with failure (persistent increase in BMI) of at least one year of conventional lifestyle intervention (nutritional and physical care) were recruited in the cohort of obese adolescents followed in the Pediatric Department. Secondary obesity (of endocrine or syndromic origin) was excluded by appropriate genetic and hormonal testing. Inclusion criteria were in agreement with the current recommendations for bariatric surgery for adolescents [12] and adults; all patients had a BMI ≥ 40 $kg \cdot m^{-2}$ or ≥ 35 $kg \cdot m^{-2}$ with associated comorbid conditions, showed no physical or psychological contraindication to bariatric surgery, and were 14 years old or more (because growth and puberty are nearly achieved at this age). The patients and their parents gave their written informed consents. They did not receive any financial compensation. Prior to surgery, the patients were closely followed by regular encounters with a dietician, a pediatric psychiatrist and a pediatric endocrinologist for at least 6 months, and all showed good compliance. Agreement for bariatric surgery was then given during a multidisciplinary meeting. The Midband® LAGB (M.I.D., Dardilly, France) was placed using the "pars flaccida" method, and was initially kept deflated.

After the usual post-operative care, the first inflation of the LAGB occurred at 6 weeks and was controlled by upper gastrointestinal studies. Further adjustments were made thereafter if needed, based on the symptoms described by the patients: It was a subjective but joint (surgeon and patient) assessment of the patient's weight loss, the tolerance of a solid meal and the sensation of hunger. Weight regain or plateauing of the weight loss along with the loss of a light and transient dysphagia was the indication for band filling in the clinical cohort.

1.2. Clinical, psychological, and metabolic assessment. Evaluation of comorbidities

Patient follow-up consisted of regular 3-month evaluations starting from the surgical procedure in the first year, 6-month appointments over the next 2 years, and a yearly consultation thereafter, in the Pediatric Department of the University Hospital of Angers. Additional nutritional and psychological consultations could be made if necessary.

The efficacy of LAGB for weight loss was assessed by weight and height measurements, and body mass index (BMI = weight (kg)/height $(m)^2$) and excess body weight loss calculations (EBWL, %, calculated with an ideal body weight set at BMI = 24.9 $kg \cdot m^{-2}$).

1.3. Cardiorespiratory and metabolic assessment

All the subjects had an oral glucose tolerance test (OGTT) every 6 months (75 g glucose intake, and blood glucose and insulin measurements at 0, 30, 60, 90 and 120 min). Homeostatic model assessment for insulin resistance (HOMA-IR) was calculated as follows: fasting insulinemia (μUI/ml) × fasting glycemia (mmol/l)/22.5) [13]. Standards for defining insulin resistance have not been established in children or adolescents, as there is no consensual threshold value for HOMA [14]. In 2012, reference values for insulinemia were published for a representative sample of healthy French children and adolescents from 7 to 20 years old [15]. We therefore defined insulin resistance as fasting insulinemia over 2 standard deviations (DS) for age and sex. Glucose intolerance was defined as fasting plasma glucose ≥ 110 and < 126 mg/dL, or 2-h plasma glucose ≥ 140 and < 200 mg/dL. Diabetes was defined as fasting plasma glucose ≥ 126 mg/dL, or 2-h plasma glucose ≥ 200 mg/dL [16].

Fasting triglycerides, total cholesterol and high density lipoprotein (HDL) cholesterol, liver enzymes, vitamins and mineral trace elements were also measured every 6 months, with commercially available kits. Hypercholesterolemia was defined by a total cholesterol value over the 95th percentile for age and sex, i.e. >5.5 mmol/L, as well as a low HDL level, set at <1 mmol/L [14].

Hypertension and sleep apnea were assessed through blood pressure measurement and polysomnography, respectively, before the surgical procedure and were repeated one year later if necessary. Hypertension was defined by a systolic and/or diastolic blood pressure over the 95th percentile for age and sex at two successive and distinct consultations [14]. Sleep apnea was diagnosed when the obstructive apnea–hypopnea index was > 1/h [17].

The diagnosis of non-alcoholic fatty liver disease (NAFLD) was estimated on abdominal ultrasonography when hepatomegaly occurred with increased liver echogenicity.

1.4. Quality of life and psychological assessment

Health-related quality of life was evaluated before and at one and two years post-surgery with the PedsQL™4.0 self-questionnaire [18] and the PedsQL™ Multidimensional Fatigue Scale [19] adapted for adolescents. Both self-questionnaires have been validated in pediatric chronic diseases and in the pediatric obese population [18]. These self-questionnaires were answered during regular metabolic and psychological evaluations, which took place in the Pediatric Department at University Hospital of Angers. Qualitative assessment was also performed through regular encounters with a pediatric psychiatrist, at least every 3 months and more often if needed.

1.5. Statistical analysis

Statistical analysis was performed using R® 2.13.1 and GraphPad Prim® 5.04 for Windows (GraphPad Software, San Diego, CA), with a significance level at $p < 0.05$. All data are given as median and extremes. At the time of analysis, sixteen patients had completed one year of follow-up, and only ten patients had completed two years of follow-up. There was no loss of follow-up.

Wilcoxon's paired test or the Mann–Whitney test was used as comparison test for quantitative data and Fisher's exact test for qualitative data. The Kruskal–Wallis test was used for multiple comparisons.

2. Results

2.1. Patient characteristics at inclusion

The main clinical characteristics of the 16 patients are summarized in Table 1. All had suffered from severe obesity since early childhood. Eleven of them had previously undergone one or more 3-month hospital stays in specialized pediatric obesity care centers, with a median weight loss of 13.5 kg [5–32 kg], all with relapse after discharge.

The maximal pre-operative BMI was 43.0 $kg \cdot m^{-2}$ [36.8–48.5 $kg \cdot m^{-2}$], and the BMI at LAGB was 40.6 $kg \cdot m^{-2}$ [31.9–47.5 $kg \cdot m^{-2}$]. Two thirds of the patients had morbid obesity (BMI ≥ 40 $kg \cdot m^{-2}$). All patients suffered from one or more associated comorbidities (Table 1). Five patients were insulin resistant and three patients were glucose intolerant, but none had diabetes mellitus.

2.2. Effectiveness for weight loss

The median follow-up was 25.5 months [10–41] after LAGB. Median EBWL with our care program was 13.8% ([6.1–58.5], n = 16) at one month after LAGB and stabilized around 40% between 6 months and one year (39.8% [14.2–95.6], n = 16), before reaching 49.2% ([17.1–98.1], n = 10) at 2 years. The BMI decreased from 40.6 $kg \cdot m^{-2}$ at day 0 to 36.2 $kg \cdot m^{-2}$ ([23.5–42.4], n = 16) at one year and 33.0 $kg \cdot m^{-2}$ ([23.1–42.7], n = 10) at 2 years after the procedure (Table 1). At that time, 16.3% patients were no longer obese, 50%

Table 1
Obesity-associated comorbidities and their evolution after LAGB.

	Pre-operative	One year after LAGB
Characteristics of the patients		
Number	16	16
Sex ratio (M/F)	4/12	4/12
Age (years)	17.4 [16.1–18.1]	18.5 [17.1–19.2]
Maximal BMI ($kg \cdot m^{-2}$)	43.0 [36.8–48.5]	36.2 [23.5–42.4]
Maximal excess weight (%)	72.5 [47.8–94.8]	45.4 [−5.8 to 71.6]
Comorbidities		
Articular disorders	7	1
Hypertension	3	0
Exercise dyspnea	3	0
Obstructive sleep apnea	2	0
Dysmenorrhea/amenorrhea	2	0
Insulin resistance	5	3
Glucose intolerance	3	0
Diabetes mellitus	0	0
NAFLD	5	0
Social isolation	8	2
Interrupted schooling	2	1
Depression (according to DSM IV)	8	3

Description of the number of patients suffering from diverse obesity-associated comorbidities before and at one year after LAGB. NAFLD: non-alcoholic fatty liver disease.
Insulin resistance was defined as fasting insulinemia over 2 standard deviations (DS) for age and sex [15]. Glucose intolerance was defined as fasting plasma glucose ≥ 110 and < 126 mg/dL, or 2-h plasma glucose ≥ 140 and < 200 mg/dL. Diabetes was defined as fasting plasma glucose ≥ 126 mg/dL, or 2-h plasma glucose ≥ 200 mg/dL [16].

had moderate obesity ($30 \le BMI < 35\ kg \cdot m^{-2}$), and 25% presented with severe obesity but none with a BMI above 45 $kg \cdot m^{-2}$ (Fig. 1).

2.3. Effectiveness for comorbidities

All obesity-related comorbidities improved within the first 12 months post-LAGB (Table 1). Hypertension, obstructive sleep apnea, and glucose intolerance disappeared. Articular disorders and exercise dyspnea were globally improved, but without validated evaluation tests.

Median fasting insulinemia decreased from 16.6 μU/mL [7.4–55.1] to 10.1 μU/ml [4.1–15.2] at 12 months ($p = 0.006$) and 7.0 μU/ml [5.3–10.8] at 2 years ($p = 0.004$). Median insulinemia at 2 h after OGTT decreased from 80 μU/ml [14.7–220] to 45.5 μU/ml [14–72] after one year ($p = 0.01$). HOMA-IR decreased from 3.02 [1.6–10.3] at baseline to 1.9 [0.8–3.4] at 12 months and 1.3 [1.1–2.1] at 24 months ($p = 0.004$). Three patients were still insulin resistant at 12 months, none at 24 months.

No patient presented with hypercholesterolemia but five patients had low HDL levels before LAGB, which were corrected in four of them during the first year after surgery.

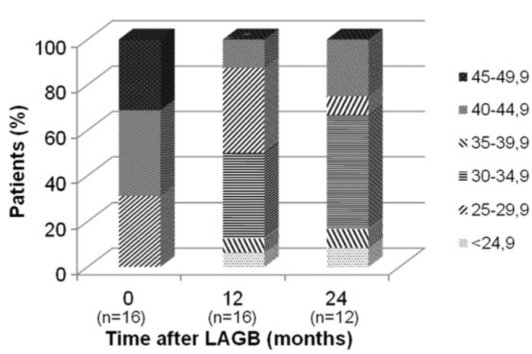

Fig. 1. Repartition of the patients by their body mass index (BMI) during the study. Values are given as percentages of patients within a group of BMI values indicated on the right of the figure. LAGB: laparoscopic adjustable gastric banding.

2.4. Quality of life and psychosocial parameters

Twelve patients had experienced difficulties in their familial environment: parental divorce in eight and mental illness in four (2 paternal alcoholics, one paternal suicide, and one paternal and maternal suicide). The mean age at the onset of weight gain was 4.9 years (from 1 to 14 years), and in all patients weight gain was temporally associated with a significant familial event.

Regarding psychosocial history, nine adolescents had had one or more psychiatric disorders (depression in 4, anxiety in 4, behavioral problems in 3, and self-mutilation in 2) and 11 suffered from eating disorders and binge eating. When asked about the reasons for excessive food intake, six patients mentioned a gain in pleasure or comfort as the main reason, two indicated a compensatory behavior to cope with anger and two indicated a compulsive overeating. Five patients had had no affect as they verbalized about overeating. At the time of surgery, 15 expressed psychological distress, with being the target of teasing for 11 patients, a decrease in self-esteem for seven, body dissatisfaction for 14, anxiety for five, and attempted suicide for one.

Health-related quality of life showed a consistent trend toward improvement of every physical and psychosocial dimension tested at one year (Table 2), although not reaching statistical significance. This improvement in general QOL (particularly the Physical Health Summary score, The Psychosocial Health Summary score) and fatigue-associated QOL tended to maintain and even to increase at two years for most of the dimensions of QOL.

2.5. Complications

No per-operative or immediate (30 days) post-operative complication was observed, except for delayed wound healing at the chamber insertion site. Eleven patients (69%) experienced one or more complications after LAGB (Table 3), but no severe complication (Clavien 3 or more) occurred during the 2 years of the survey.

No patient suffered from any vitamin (A, B12, 25-hydroxy vitamin D, E) deficiency, but five patients had mild iron deficiency with one documented anemia. They all received vitamin D every 3 months. No systematic supplementation in mineral trace elements was given.

3. Discussion

This study of 16 severely obese adolescents showed that LAGB was associated with a 10.2 $kg \cdot m^{-2}$ decrease in BMI after 2 years, equivalent to a 49.2% EBWL ($p < 0.001$). Systematic evaluation for organic and

Table 2
Results of the PedsQL™ and the Fatigue PedsQL™ evaluation.

Evaluated dimension	Score before LAGB (%) n = 10	Score at 1 year (%) n = 6	Score at 2 years (%) n = 5
General PedsQL™	**72.8 [30.2–82.3]**	**79.7 [35.6–89.9]**	**80.6 [41.9–100]**
Physical Health Summary Score	**74.9 [40.6–90.6]**	**81.3 [62.5–93.7]**	**84.4 [62.5–100]**
Psychosocial Health Summary Score	**71.7 [26.7–81.7]**	**79.2 [26.7–91.7]**	**78.3 [35.0–100]**
Emotional functioning	62.5 [10–90]	82.5 [30–100]	55 [30–100]
Social functioning	57.5 [25–90]	90.0 [0–100]	85 [20–100]
School functioning	67.5 [40–90]	72.5 [50–85]	90 [55–100]
Fatigue PedsQL™	**69.4 [45.8–90.3]**	**77.5 [55.6–98.6]**	**83.3 [62.5–97.2]**
General fatigue	75 [50–91.7]	76.2 [62.5–100]	83.3 [62.5–100]
Sleep/rest fatigue	70.8 [8.3–87.5]	75.0 [25–100]	66.7 [66.7–91.7]
Cognitive fatigue	68.7 [50–100]	87.5 [79.2–100]	100 [58.3–100]

Evolution of the different dimensions of the QOL questionnaires before and after LAGB. Results are given as median values and extremes.

Table 3
Surgical complications of LAGB at 2 years.

Clavien	Type of surgical complication	Number of patients (%)
1	Food intolerance (re-educational procedure)	7 (43.8%)
2	Food intolerance with deflation of the LAGB	2 (12.5%)
2	Mild dilatation of the upper gastric pouch	1 (6.25%)
2	Mild dilatation of the esophagus	2 (12.5%)
3b	Device failure	2 (12.5%)
3b	Ablation (inefficiency)	1 (6.25%)
3b	LAGB slippage	0
3b	Intra-gastric migration	0
3b	Infection	0
3b–4	Hemorrhage	0
3b–4	Gastric or intestinal leakage	0
5	Death	0

The surgical complications encountered with LAGB are described and classified according to the score of Clavien. LAGB: laparoscopic adjustable gastric banding.

psychosocial comorbidities showed that most of the obesity-associated comorbidities resolved during the first year post-surgery.

With the worldwide rise in pediatric obesity and the excellent results of adult weight loss surgery as opposed to lifestyle interventions, bariatric surgery has become a legitimate option for the treatment of severely obese adolescents. It has been increasingly used in this young population over the last 20 years [20], in part due to the development of laparoscopic procedures. The two most commonly used surgical procedures are the Roux-en-Y gastric bypass (RYGB) and the LAGB, and there is now consensus that a multidisciplinary approach in specialized pediatric care centers is needed [12,21]. Roux-en-Y gastric bypass appears to be more efficient than LAGB over the short and middle term for adolescent weight loss, but at the cost of more frequent and more serious post-operative complications [22,23]. In 1615 children undergoing bariatric surgery, Zwinscher et al. reported a 0.2% complication rate after LAGB compared with 3.5% with RYGB [20]. Furthermore, a recent review of long-term results of adult bariatric surgery showed similar efficiency (EWL around 54%) with LAGB and gastric bypass (GBP) after 15 years of follow-up [24]. The sleeve gastrectomy procedure, which has gained increasing academic acceptance for adolescents since the first report in 2008 [25], displays good results regarding weight loss and comorbidities resolution in recent reports ([26–28]), and possibly better outcomes than LAGB ([29]). Nevertheless, its complication rate, even if lower than with LAGB, includes very severe complications, some of them even leading to death ([29]). In France, only a few pediatric surgical centers are authorized to practice bariatric surgery. Short term results of single-port sleeve gastrectomy in French adolescents with severe obesity have just been reported by Pourcher et al. [30]. In our center, we selected LAGB as the preferred procedure, mainly because of its reversibility, since our obese patients have not yet attained their legal majority.

In terms of weight loss, our results are in agreement with those of 12 previous reports (Table 4), for a median EBWL at 24 months of 49.2% and a final equivalent BMI of 32.8 $kg\cdot m^{-2}$. Altogether, two thirds of our patients no longer presented severe obesity at 24 months post-LAGB. These results are better than those obtained with lifestyle interventions: a recent meta-analysis on this topic [31] reported a pooled BMI reduction of 1.25 $kg\cdot m^{-2}$ from 12 studies including 899 patients. Of note, two thirds of our patients had already had intensive life-style intervention consisting of a 3-month stay in a dedicated obesity care center, with relapse.

Most obesity-related comorbidities resolved within the first year after surgery. Our results, albeit coming from a small series, reinforce the observation that LAGB may be more efficient for resolving metabolic syndrome and other comorbidities in adolescents than in adults. Other studies reported as high as 100% resolution of metabolic syndrome [40] or hypertension [39].

Eighty-seven percent of the adverse effects were food intolerance and/or gastric pouch or lower esophagus dilation on gastric enema, and they were resolved with simple dietary advice or partial deflation of the LAGB. Only one patient had the LAGB removed in accordance to her choice, because of psychological intolerance. Two patients experienced connector failure, requiring a change of the puncture device. No severe surgical, medical or nutritional complication of LAGB occurred. Specifically, we did not observe in our cohort severe surgical complications such as LAGB slippage, intra-gastric migration, infection, hemorrhage, gastric or intestinal leakage. Reported incidences of complications after LAGB in adolescents are variable between studies. Recent reviews found a 6%–10% surgical complication rate after LAGB in adolescents [12], mostly device failure or LAGB removal for slippage (in the oldest series), psychological intolerance or weight loss failure [23,44]. At the opposite, Zwinscher et al. reported a 0.2% complication rate after LAGB, but only took into account the immediate post-operative complication rate [20]. In this study, the post-operative complication rate before discharge was 0%.

Obesity has a significant impact on the quality of life (QOL), especially during adolescence. Hence, Swallen et al. reported a strong correlation between pediatric overweight and the overall decrease in QOL scores (odds ratio 2.17 and 4.49 for overweight and obesity, respectively) and functional limitation (odds ratio 1.81 and 1.91, respectively) [5]. Schwimmer et al. compared the scores obtained on the General PedsQL™ by obese children, healthy ones and children with cancer [45]. The mean score was 67% for the obese children, comparable to that of the cancer patients (odds ratio 1.3, 95% CI: 0.8–2.3) and lower than the 83% score obtained in the general population (odds ratio 5.5, 95% CI: 3.5–8.7).

The initial median score of the General PedsQL™ in our series was low at 71%, in concordance with Schwimmer's results. We believe that the observed differences after one and two years were not statistically

Table 4
Main results of the studies concerning LAGB in adolescents since 2000.

	Number of patients	Age (years)	Pre-operative BMI ($kg\cdot m^{-2}$)	Length of survey (months)	Post-operative BMI ($kg\cdot m^{-2}$)	BMI loss ($kg\cdot m^{-2}$)	EBWL (%)	Complications (requiring surgery)
Abu-Abeid et al. 2003 [32]	11	11–17	46.4	23	32.1	14.3	NR	0 (0%)
Angrisani et al. 2005 [33]	58	15–19	46.1	12 +	35.9	10.2	45.6	8 (13.8%)
Fielding et al. 2005 [34]	41	12–19	42.4	34	29	13.4	70	NC
Yitzhak et al. 2006 [35]	60	9–18	43	36 +	30	13.0	NR	8 (13.3%)
Silberhumer et al. 2006 [36]	50	9–19	45.2	34.7	32.6	12.6	61.4	1 (2%)
Al-Qahtani 2007 [37]	51	9–19	49.9	12	NC		60	1 (2%)
Nadler et al. 2008 [38]	73	13–17	48	24	38.5	9.5	51.5	9 (12.3%)
Holterman et al. 2010 [39]	20	14–17	50	18	40.6	9.4	41	1 (10%)
O'Brien et al. 2010 [40]	25	14–18	42.3	24	29.6	12.7	78.8	8 (33.3%)
Zitsman et al. 2011 [41]	100	14–19	48.2	12	41.5	6.7	31.9	9 (19.1%)
Silva et al. 2012 [42]	14	16.3	46.1	36	33	13.1	48	3 (21.4%)
Lee et al. 2012 [43]	23	17.2	47.0	24	NC		29.7	2 (8.7%)
Schmitt et al. 2015	16	16–18	43	24	32.8	10.2	49.2	3 (18.8%)

Values are given in terms of means for body mass index (BMI) and excess body weight loss (EBWL). Complications are presented in numbers and percent. NC: not communicated.

significant in this study because the number of subjects was too low and the subjects presented large inter-individual differences. Overall, the improvement in the PedsQL™ score mostly came from the Physical Health Summary Score (+10%), whereas the Psychosocial Health Summary Score only slightly increased at two years (+6%) with better social and school functioning (Table 2). Nevertheless, these data are consistent with the few series in the literature that report QOL scores after gastric banding. Hence, Holterman et al. reported an increase in the General PedsQL™ score from 66% to 89% at 18 months [39].

Analysis of the Fatigue PedsQL™ scores showed the same rapid improvement from 69.4% to 83.3% in 2 years. It was mostly improved in its psychological dimensions, namely the General Fatigue Score (+8%), and the Cognitive Fatigue Score (+31%). This Fatigue PedsQL™ score is comparable to the score of 67% reported by Varni et al. in obese children [19], which was similar to that of children with cancer (68.5%). Our results on the Fatigue PedsQL™ are the first results ever reported after LAGB and they show that bariatric surgery may help obese adolescents to achieve a fatigue-related QOL similar to that of healthy children (82.2%).

We found that a significant proportion of subjects made the link between the beginning of their weight gain and a negative life event. Concerning psychosocial characteristics, more than half of the cohort had a psychiatric history, and most had mental distress, such as a significant share of teasing or taunting, depression, body dissatisfaction and reduced self-esteem, indicating the strong link between psychiatric comorbidities and obesity. This element should draw attention to the vulnerability of these young obese patients and provide support for prolonged psychiatric follow-up. Moreover, we found an improvement in psychological distress one year after bariatric surgery (depressive symptoms, social isolation). These adolescents showed a devaluation of body image and mentioned feelings of shame and disgust [46]. Few emotions were developed in connection with food intake, this aspect being in line with the alexithymia described in obese patients and characterized by a difficulty in identifying and describing feelings, a diminution of fantasy and a concrete and externally-oriented thinking style [47].

The results of our study include nevertheless some limitations. Our results were gained within the frame of a specialized obesity center in a University Hospital and may not be true in other settings. In addition, we reported changes in objective measurements (namely weight loss) together with trends in changes of subjective measurements (QOL scores). Finally, the small number of patients of this prospective analysis does not authorize definitive conclusions.

In our study, as in many others evaluating bariatric surgery in the pediatric population [48] as well as in adults [49], sex ratio was in favor of female patients. This was a potential bias, because it has been suggested that gender could influence eating behaviors [50,51]. We cannot exclude that predominance of female gender in our cohort may have influenced the results. The small number of patients in our study makes the comparison of metabolic and psychological parameters between genders inappropriate.

In conclusion, our study highlights the interest of LAGB for weight loss and improvement of obesity-associated metabolic comorbidities in adolescents and gives some indication on the improvement of QOL and psychiatric symptoms. Unfortunately, our cohort was too small to draw any definite conclusion. Long-term careful follow-up remains thus necessary to confirm our results on weight loss, metabolic syndrome and QOL.

Conflict of interest

Dr. Schmitt reports non-financial support from ©Ethicon outside the submitted work, and Dr. Topart reports personal fees from four different surgical laboratories, all outside the submitted work. For all other authors, no other competing financial interests exist.

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