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Trends in adolescent bariatric surgery evaluated by UHC database collection

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Abstract
Background With increasing childhood obesity, adolescent bariatric surgery has been increasingly performed. We used a national database to analyze current trends in laparoscopic bariatric surgery in the adolescent population and related short-term outcomes.
Methods Discharge data from the University Health System Consortium (UHC) database was accessed using International Classification of Disease codes during a 36 month period. UHC is an alliance of more than 110 academic medical centers and nearly 250 affiliate hospitals. All adolescent patients between 13 and 18 years of age, with the assorted diagnoses of obesity, who underwent laparoscopic adjustable gastric banding (LAGB), sleeve gastrectomy (SG), and laparoscopic Roux-en-Y gastric bypass (LRYGB) were evaluated. The main outcome measures analyzed were morbidity, mortality, length of hospital stay (LOS), overall cost, intensive care unit (ICU) admission rate, and readmission rate. These outcomes were compared to those of adult bariatric surgery.
Results Adolescent laparoscopic bariatric surgery was performed on 329 patients. At the same time, 49,519 adult bariatric surgeries were performed. One hundred thirty-six adolescent patients underwent LAGB, 47 had SG, and 146 patients underwent LRYGB. LAGB has shown a decreasing trend ($n = 68$, 34, and 34), while SG has shown an increasing trend ($n = 8$, 15, and 24) over the study years. LRYGB remained stable ($n = 44$, 60, and 42) throughout the study period. The individual and summative morbidity and mortality rates for these procedures were zero. Compared to adult bariatric surgery, 30 day in-hospital morbidity (0 *vs.* 2.2 %, $p < 0.02$), the LOS (1.99 ± 1.37 *vs.* 2.38 ± 3.19, $p < 0.03$), and 30 day readmission rate (0.30 *vs.* 2.02 %, $p < 0.05$) are significantly better for adolescent bariatric surgery, while the ICU admission rate (9.78 *vs.* 6.30 %, $p < 0.02$) is higher and overall cost ($\$9{,}375 \pm 6{,}452$ *vs.* $\$9{,}600 \pm 8{,}016$, $p = 0.61$) is comparable.
Conclusion Trends in adolescent laparoscopic bariatric surgery reveal the increased use of sleeve gastrectomy and adjustable gastric banding falling out of favor.

Keywords Adolescent · Bariatric surgery · Sleeve gastrectomy · Laparoscopic adjustable gastric banding · Roux-en-y gastric bypass · National trends

The incidence of childhood obesity has been increasing rapidly in the last decade [1]. The serious complications associated with obesity are well documented in the literature [2]. There is growing interest in the general public and political realm to control this epidemic by increasing awareness related to exercise and healthy eating behaviors. However, some adolescents are morbidly obese, which often requires bariatric surgery. It has been shown that obesity in the adolescent years increases the incidence of morbid obesity in adulthood, which has many associated medical consequences [3].

The health benefits of bariatric surgery for the morbidly obese are well documented in the literature [4]. Also, it has been shown that nadir weight after bariatric surgery is dependent on the initial weight; hence obese adolescents should be treated early to prevent super-morbid obesity in

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adulthood [5]. However, many physicians are hesitant to refer an adolescent for bariatric surgery due to the concerns of growth and unknown long-term effects [6].

As the minimally invasive technique for bariatric surgery became the norm in adult bariatric surgery, more and more adolescents are willing to undergo these procedures, primarily because of decreased morbidity as well as the potential benefits of successful weight loss. Morton et al. [7] reported the national trends in adolescent bariatric surgery based on the Kids' Inpatient Database from 1997 to 2003, which showed an increasing trend in the use of bariatric surgery in this population.

The aim of the present study was to evaluate the recent trends in all minimally invasive bariatric surgeries performed from 2008 to 2011 using an administrative database of academic centers. The primary objective was to evaluate the frequency of various procedures annually over the course of these 3 years. We also evaluated the short-term outcomes of these procedures compared to adult bariatric surgeries performed during the same period.

Materials and methods

Database description

The University Health System Consortium (UHC) is an alliance of more than 110 academic medical centers and nearly 250 affiliate hospitals. The database provides comprehensive, comparative clinical, operational, and financial data, and analyses to hospitals for improving the practice of health care. The database contains discharge information on in-patient hospital stay along with patient characteristics and the following perioperative outcomes: mortality, overall morbidity, hospital length of stay (LOS), intensive care unit (ICU) admission rate, 30 day readmission rate, and hospital costs. UHC's Clinical Data Base/Resource Manager (CDB/RM) allows member hospitals to compare outcomes for performance improvement purposes and has previously been used in studies [8]. The estimated hospital costs are calculated in the UHC database using a ratio of cost/charge.

Study design

A retrospective study design was used after obtaining Institutional Review Board and UHC approval. A multicenter analysis of patient outcomes and cost was performed using the discharge data from October 2008 to September 2011 for adolescent patients (13–18 years old). The UHC database was accessed using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes for bariatric surgery. Bariatric surgery patients were identified by principal procedure codes specific to laparoscopic gastric bypass (44.38), sleeve gastrectomy (43.89), and laparoscopic adjustable gastric banding (LAGB) (44.95). We also utilized diagnosis codes for obesity (27800, 27801, 27802, 2788, 2780, 278, V8554, V8553, V854, V8541, V8542, V8543, V8544, V8545, V853, V8530, V8531, V8532, V8533, V8534, V8535, V8536, V8537, V8538, V8539) to identify procedures performed only with intention of weight loss to further validate the ICD-9-CM codes for bariatric surgery. Simultaneously, data were obtained for the same procedures in the adult population for comparison of total outcomes.

Main outcome measures

The data on the various procedures and annual report were obtained to analyze trends. The data on several surgical outcome variables were also analyzed, including observed mortality, overall morbidity, LOS stay, ICU admission, 30 day readmission, and hospital costs. The UHC database identifies complications based on preset data during the index hospitalization only. As such, any readmissions within the 30 days after discharge are placed in the category of readmission only and not in the morbidity section.

Data analysis

Data are expressed as the frequency percentage for categorical variables such as mortality, overall morbidity, ICU admission, and 30 day readmission. A χ^2 test was used to compare these variables. Mean $\pm$ standard deviation was used to express the continuous variables such as LOS and costs, which were compared using a *t*-test. Data were considered significant at $p < 0.05$. Statistical analysis was performed using Prism ver. 5.0, software (GraphPad Software, San Diego, CA).

Results

Demographics

Between October 2008 and September 2011, 329 adolescent patients (13–18 years of age) underwent bariatric surgery. Laparoscopic Roux-en-Y gastric bypass (LRYGB) was the most commonly performed procedure (45 %) followed by LAGB (41 %) and sleeve gastrectomy (SG, 14 %). The three groups were comparable with respect to demographics (Table 1). Of UHC-specific comorbidities in adolescents, hypertension (24.6 %), chronic pulmonary disease (19.8 %), depression (15.5 %), diabetes (14.9 %), liver disease (14.9 %), and hypothyroidism (7 %) were the

Table 1 Demographics

	LAGB ($n = 136$)	LRYGB ($n = 146$)	SG ($n = 47$)
Age			
13–14 years	7	4	3
15–16 years	52	27	13
17–18 years	77	115	31
Gender			
Male	44	45	14
Female	92	101	33
Race			
White	79	96	29
Black	24	27	3
Other	33	23	15

Table 2 Comorbidities

	Adolescent patients ($n = 329$) (%)	Adult patients ($n = 49{,}519$) (%)	p value
Hypertension	81 (24.6)	28,248 (57)	<0.0001
CPD	65 (19.8)	9,672 (19.5)	0.97
Diabetes	49 (14.9)	16,350 (33)	<0.0001
Hypothyroidism	23 (7)	5,893 (11.9)	0.0078
Liver disease	49 (14.9)	6,169 (12.4)	0.21
Depression	51 (15.5)	11,203 (22.6)	0.0026

most common. Comparison of these comorbidities in the adult population is shown in Table 2.

Annual trends

On a yearly basis, the total number of bariatric procedures performed did not change significantly. However, the trend shows SG increasing in popularity, from 6.7 % in the initial year to 24 % in the last year ($p < 0.01$). On the other hand, the use of LAGB has significantly decreased from 56.7 to 34 % ($p < 0.01$). LRYGB was stable throughout the study period (Fig. 1).

Perioperative outcomes

The perioperative outcomes of these procedures in the adolescent population are very good (Table 3). The individual and summative morbidity and mortality rates for these procedures were zero. The LOS, ICU admission, and mean direct costs were significantly lower for LAGB compared to LRYGB and SG. However, the readmission rates of the three procedures are comparable.

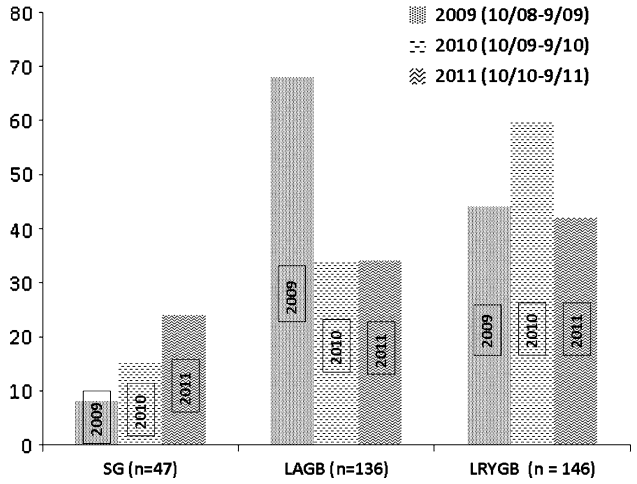

Fig. 1 Trends of procedures in the adolescent population from October 2008 to September 2011

Compared to adult bariatric surgery (Table 4), 30 day in-hospital morbidity (0 *vs.* 2.2 %, $p < 0.02$), the length of hospital stay (1.99 ± 1.37 *vs.* 2.38 ± 3.19, $p < 0.03$), and 30 day readmission rate (0.30 *vs.* 2.02 %, $p < 0.05$) of adolescent bariatric surgery were significantly better. The ICU admission rate (9.78 *vs.* 6.30 %, $p < 0.02$) was higher in adolescent bariatric surgery. However, the overall cost ($9,375 ± 6,452 *vs.* $9,600 ± 8,016, $p = 0.61$) was comparable between the two groups.

Discussion

Bariatric surgery in the adolescent population has reached a plateau, with the same number of procedures performed every year among the UHC affiliate hospitals, in contrast to the increasing trend noted earlier by Morton et al. [7] based on the Kids' Inpatient Database and by Nguyen et al. [9] based on the UHC database. In the early part of the 21st century, growing enthusiasm over these procedures coupled with the introduction of safe minimally invasive approaches to bariatric surgery resulted in a sudden increase of these procedures [7, 9, 10]. However, in recent years, adult bariatric surgery has seen a plateau in the number of procedures performed across the nation [11, 12]. Likewise, the number of bariatric procedures performed in the adolescent population has seen a plateau effect, as seen in this study.

The use of sleeve gastrectomy during the study period increased as the use of adjustable gastric banding decreased. This trend is attributable to the increasing coverage of sleeve gastrectomy by most insurance companies beginning in 2009. The role of sleeve gastrectomy as a bariatric procedure is well established now as per the updated position statement of the American Society of

Table 3 Perioperative outcomes of individual procedures within the adolescent population

	LAGB ($n = 136$)	LRYGB ($n = 146$)	SG ($n = 47$)
Observed mortality (%)	0.00	0.00	0.00
Overall morbidity (%)	0.00	0.00	0.00
LOS (days) (mean ± SD)	1.10 ± 0.37	2.55 ± 1.50	2.79 ± 1.33
ICU cases (%)	4.00	8.97	25.53
Cost (US $) (mean ± SD)	6,113 ± 2,640	11,365 ± 6,626	13,356 ± 9,366
30-day readmission (%)	0.00	0.69	0.00

LOS length of stay; *ICU* intensive care unit

Table 4 Comparison of outcomes with adult population

	Laparoscopic adolescent surgeries ($n = 329$)	Laparoscopic adult surgeries ($n = 49{,}519$)	p value
Observed mortality	0.00	0.07	0.63
Overall morbidity	0.00	2.2	0.01
LOS (days) (mean ± SD)	1.99 ± 1.37	2.38 ± 3.19	0.03
ICU cases (%)	9.78	6.30	0.02
Cost (US $) (mean ± SD)	9,375 ± 6,452	9,600 ± 8,016	0.61
30 day readmission (%)	0.30	2.02	0.04

LOS length of stay; *ICU* intensive care unit

Metabolic and Bariatric Surgery [13, 14]. The decreasing use of LAGB is noteworthy as sleeve gastrectomy continues to increase in popularity; this is due in part to the increasing evidence of the long-term complications associated with adjustable gastric banding [15].

Our study focused only on the trends and perioperative outcomes of these procedures within the adolescent population. The excess weight loss is not identified in this study, but there have been numerous studies that evaluated the efficacy and outcomes of these procedures within the adolescent population [16–19]. In our study, the actual in-hospital morbidity and mortality during the index admission for these procedures is nil compared to the small risk in the adult population. The LOS is also better in the adolescent population owing to absence of any morbidity. The better perioperative outcomes noted in this population are probably a result of the young age of the patients. Also, the incidence of preoperative comorbidities in this population is low compared to the adult population, which results in a healthier cohort. On the other hand, the use of ICU admission is greater in the adolescent population compared to adult population even though there are fewer associated comorbidities in this population. This phenomenon is likely due to the surgeons being cautious, as these procedures are not routinely performed in the adolescent population.

Our study has a few limitations. First, the UHC database provides only 30 day outcomes; we did not have any long-term outcomes, such as excess body weight loss, weight regain, long-term complications, reoperations, and nutritional outcomes, to look at. Second, there is no specific definition of morbid obesity; we included the updated BMI codes of weight greater than the 85th percentile for age in our search. Third, this is a retrospective study based on administrative data, and hence the data are as good as the person entering it. Subsequently, any procedures that are not correctly identified in the data were not included in the study. Finally, the UHC database is compiled from discharge abstract data and is limited to in-hospital morbidity and mortality with no mention of outpatient follow-up. Thus, the study does not truly represent 30 day morbidity and mortality. In spite of these limitations, our study shows a recent national trend in bariatric surgery within the adolescent population, noting the increasing use of laparoscopic sleeve gastrectomy as the use of LAGB declines.

Conclusion

In conclusion, the use of bariatric surgery in the adolescent population has reached a plateau in concordance with its use in the adult population and is associated with minimal morbidity and mortality. Laparoscopic sleeve gastrectomy has gained popularity in recent years while LAGB is falling out of favor. Further studies are required to evaluate the safety, long-term efficacy, and outcomes of sleeve gastrectomy in the adolescent population.

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