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ORIGINAL CONTRIBUTIONS

Does Certification as Bariatric Surgery Center and Volume Influence the Outcome in RYGB—Data Analysis of German Bariatric Surgery Registry

Christine Stroh[1,2] · F. Köckerling[3] · V. Lange[3] · S. Wolff[4] · C. Knoll[5] · C. Bruns[4] · Th. Manger[1,2] · Obesity Surgery Working Group, Competence Network Obesity

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Abstract
Aim To examine the association between the certification as bariatric surgery center and volume and patient outcome, data collected in the German Bariatric Surgery Registry were evaluated. All data were registered prospectively in cooperation with the Institute of Quality Assurance in Surgery at Otto-von-Guericke University Magdeburg.
Methods Data collection began in 2005 for all bariatric procedures in an online database. Participation in the quality assurance study is required for all certified bariatric surgery centers in Germany. Descriptive evaluation and matched pairs analysis were performed. Patients were matched via propensity score taking into account BMI, age, and incidence of comorbidities.
Results During the period from 2005 to 2013, 3083 male and 10,639 female patients were operated on with the RYGB primary approach. In Centers of Competence (77.2 %) and non-accredited hospitals (76.3 %), the proportion of female patients was significantly lower than in Centers of Reference/Excellence (78.7 %; $p = 0.002$). The mean age in Centers of Reference/Excellence (41.2 years) was significantly lower than in Centers of Competence (43.2 years; $p < 0.05$). Propensity score analysis was performed to compare matched patients with regard to BMI, age, and incidence of comorbidities. The rate of general and surgical postoperative complications and mortality rate was significantly lower in certified Centers of Reference/Excellence compared to Centers of Competence with 29 and non-certified hospitals.
Conclusion There is evidence of improved patient outcome in certified bariatric surgery centers with higher volume. The study supports the concept of certification. There are different factors which can and cannot be preoperatively modified and influence the perioperative outcome.

Keywords RYGB · Hospital volume · Complication rates · Mortality rate · German bariatric surgery registry

Introduction

Germany is one of the countries with a high prevalence of overweight and obese individuals [1]. Seventy-five percent of men and 59 % of women between the ages of 25 and 69 years are overweight or even obese [2]. This means that among EU countries, Germany ranks first for both genders [2].

In 2009, the German Society for General and Visceral Surgery (DGAV) set up a program for certification of centers for bariatric and metabolic surgery aimed at improving the quality of bariatric surgery. Based on that program, those hospitals wishing to obtain certification are required to have in place certain structural elements, comply with specified treatment procedures, record prospective data on all bariatric operations in the German Bariatric Surgery Registry (GBSR), and undergo on-site audits at intervals of every 3 years. Based on the number of cases and scientific activities, the

✉ Christine Stroh
Christine.Stroh@wkg.srh.de

Obesity Surgery Working Group, Competence Network Obesity

1 Department of General, Abdominal and Pediatric Surgery, SRH Municipal Hospital Gera, Strasse des Friedens 122, D-07548 Gera, Germany

2 Institute for Quality Assurance in Surgical Medicine at the University Hospital, Magdeburg, Germany

3 Vivantes Hospital, Berlin, Germany

4 University Hospital, Magdeburg, Germany

5 StatConsult, Magdeburg, Germany

certification process recognizes three different levels. In addition to other requirements, the certified Center of Competence (cCoC) must perform 50, the certified Center of Reference 100, and the certified Center of Excellence (cCoR/E) 200 bariatric operations each year (http://www.dgav.de).

Studies from Birkemeyer et al. [3–5] showed that safety culture is associated with lower rates of serious surgical complications in bariatric surgery, the technical skill of practicing bariatric surgeons was associated with fewer postoperative complications, and lower rates of reoperation, readmission, and visits to the emergency department and rates of serious complications are inversely associated with hospital and surgeon procedure volume but unrelated to Center of Excellence accreditation by professional organizations.

A systematic review showed that there was strong evidence of improved patient outcomes in the hands of high-volume surgeons and high-volume centers [6]. That study supported the concept of Bariatric Surgery Center accreditation [6]. By analyzing the GBSR data, this present paper now aims to identify whether the relationship between volume and outcome identified for RYGB can also be confirmed by the registry data. Furthermore, the paper explores whether the German certification system in reality leads to differences in outcome between certified and non-certified centers as well as between Centers of Competence and Centers of Reference/Excellence.

Methods

The data from the GBSR have been registered prospectively in an online database since 1 January 2005 at the Institute of Quality Assurance in Surgical Medicine of the Otto-von-Guericke University Magdeburg [7]. This paper evaluates the data on RYGB procedures performed at cCoR/E with a total case load of bariatric procedures of more than 100 cases per year, cCoC with 50 bariatric operations per year, and non-certified hospitals with an operation rate of less than 50 bariatric procedures yearly. It was planned that by 31 December 2013, all centers participating in GBSR would be evaluated with regard to their status of certification. The first step of analysis entailed a descriptive presentation of baseline characteristics and complication rates for non-certified vs. certified and cCoC vs. cCoR/E, respectively. Due to the high variability of data, matched pairs analysis was performed as a second step for certified centers vs. hospitals without certification and additionally for cCoC vs. cCoR/E. Matching was performed by propensity score of patient characteristics (gender, age, BMI, existence of comorbidities, total number of comorbidities, IDDM, NIDDM, hypertension, and sleep apnea). Operation time, intraoperative as well as general and surgical postoperative complications, 30-day mortality, and follow-up rate were the outcome variables for each comparison after propensity score matching. Comparison with the results in the literature was performed.

Statistical Analysis

The descriptive statistical analysis comprised presentation of absolute and relative frequencies for nominal data and mean, standard deviation, and minimum and maximum values for continuous variables. The median was presented for continuous variables with high variation. All calculations were performed by StatConsult GmbH using SAS® 9.2, SAS Institute (Cary, NC, USA) with a type 1 error rate of $\alpha = 0.05$. All tests were deliberately carried out to the full level of significance.

To determine a clear effect of certification of a bariatric center, matched pairs analysis based on propensity score was performed. The propensity score was estimated by a logistic regression model in which the certification type is regressed on baseline characteristics of the RYGB patient. The estimated propensity score is then the predicted probability of exposure to the centers type from the logistic regression model. In the matching of non-certified hospitals vs. certified centers, the patients were matched by the closest propensity score in 1:2 proportion by greedy algorithm with 20 % of standard error. For the second matched pairs analysis of certified cCoC vs. certified cCoR/E, the patients were matched in a 1-to-1 merge by greedy algorithm with maximum of 20 % of standard error [8]. In each paired analyses, the baseline characteristics were checked first by using a robust t test for continuous variables (age and BMI) or a χ^2 test for nominal data (gender, existence of comorbidities, prevalence of IDDM, NIDDM, hypertension, and sleep apnea). In cases where there was no significant difference between the two groups, the outcome parameters were evaluated by robust t test (operation time) or Fisher's exact test for intraoperative, general, and specific postoperative complications as well as for 30-day mortality and follow-up rates. For rare nominal events (complications), Fisher's exact test was applied.

Results

Within the study period (from 2005 to 2013), 13,722 patients underwent primary RYGB for morbid obesity in 120 centers (Table 1). Figure 1 demonstrates the annual increase in RYGB in Germany within the study period.

Unadjusted Analyses

The unadjusted results for "non-certified hospitals" vs. "certified centers" are shown in Table 1. Furthermore, the corresponding results of the certified subgroups (cCoC vs. cCoR/E) can be found in Table 2.

Table 1 Distribution of demographic and comorbidity factors as well as complication and mortality rates for non-certified vs. certified hospitals

Variable	Category	Unit	Non-certified hospitals ($N = 3056$ patients; $N = 83$ center)	Certified centers ($N = 10{,}666$ patients; $N = 37$ center)	p value
RYGB per center		Mean/range	36.8/1–342	288.3/8–2750	
RYGB per center per year		Mean	11.7	47.4	
Gender	Male	*N*/%	738/24.1	2345/22.0	0.012
	Female		2318/75.9	8321/78.0	
Age [years]		Mean/SD	42.7/11.3	42.1/11.1	0.005
BMI [kg/m^2]		Mean/SD	48.4/7.4	47.9/7.0	<.001
Patients with comorbidities	Yes	*N*/%	2705/88.5	9273/86.9	0.021
	No		351/11.4	1393/13.1	
Hypertension	Yes	*N*/%	1903/62.3	6041/56.6	<.001
	No		1153/37.7	4625/43.4	
Diabetes (total)	Yes	*N*/%	1126/40.6	3440/35.7	<.001
	No		1649/59.4	6193/64.3	
Type 2 insulin dependent diabetes	Yes	*N*/%	419/15.1	1082/11.2	<.001
	No		2356/84.9	8551/88.8	
Type 2 non-insulin dependent diabetes	Yes	*N*/%	592/21.3	2134/22.2	0.358
	No		2183/78.7	7499/77.8	
Heart disease	Yes	*N*/%	289/9.5	790/7.4	<.001
	No		2767/90.5	9876/92.6	
Pulmonary disease	Yes	*N*/%	570/18.7	1947/18.3	0.617
	No		2486/81.3	8719/81.7	
History of pulmonary embolism	Yes	*N*/%	25/0.8	67/0.6	0.257
	No		3031/99.2	10,599/99.4	
Sleep apnea	Yes	*N*/%	683/22.4	2078/19.5	<.001
	No		2373/77.6	8588/80.5	
Gallstones	Yes	*N*/%	157/5.1	514/4.8	0.472
	No		2899/94.9	10,152/95.2	
Gastroesophageal reflux disease	Yes	*N*/%	510/16.7	2281/21.4	<.001
	No		2546/83.3	8385/78.6	
Bone disease	Yes	*N*/%	1517/49.6	4007/37.6	<.001
	No		1539/50.4	6659/62.4	
Smoking	Yes	*N*/%	297/9.7	1234/11.6	0.004
	No		2759/90.3	9432/88.	
Alcoholism	Yes	*N*/%	22/0.7	176/1.7	<.001
	No		3034/99.3	10,490/98.3	
Intraoperative complications	Yes	*N*/%	146/4.8	144/1.4	<.001
	No		2910/95.2	10,522/98.6	
General postoperative complications	Yes	*N*/%	245/8.0	488/4.6	<.001
	No		2811/92.0	10,178/95.4	
Surgical postoperative complications	Yes	*N*/%	230/7.5	467/4.4	<.001
	No		2826/92.5	10,199/95.6	
Leakage at GJA	Yes	*N*/%	85/2.8	155/1.5	<.001
	No		2971/97.2	10,511/98.5	
Sepsis	Yes	*N*/%	28/0.9	35/0.3	<.001
	No		3028/99.1	10,631/99.7	
Peritonitis	Yes	*N*/%	34/1.1	60/0.6	0.001
	No		3022/98.9	10,606/99.4	
Bleeding with reoperation	Yes	*N*/%	24/0.8	78/0.7	0.759
	No		3032/99.2	10,588/99.3	
30-day mortality	Yes	*N*/%	14/0.5	17/0.2	0.002
	No		3039/99.5	10,618/99.8	

No information's on age for eight and on BMI for three patients

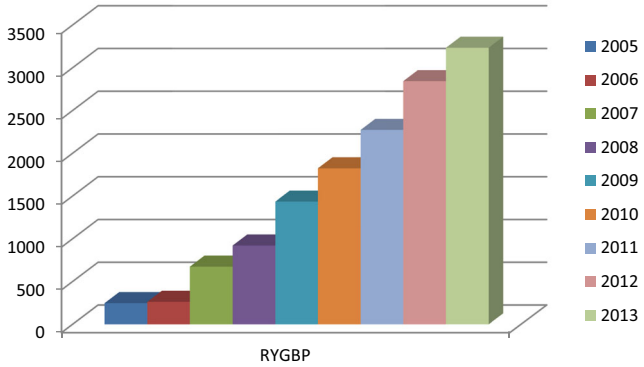

Fig. 1 Number of RYGB operations recorded annually

Demographic Data

During the period from 2005 to 2013, 3083 male and 10,639 female patients were operated on.

In non-certified centers, the proportion of female patients was slightly lower than in certified centers (75.9 vs. 78.0 %; $p = 0.012$). Within the certified subgroups (cCoC vs. cCoR/E), no differences could be found.

The mean age of 41.2 ± 11.0 years in cCoR/E was significantly lower than in cCoC (43.2 ± 11.0 years; $p < 0.001$). However, the differences in age were not clinically relevant. Also, the differences in BMI were not clinically relevant. Additional plots for median age per center and median BMI per center, respectively, were created (Figs. 2 and 3). Here, the BMI of patients with RYGB did not differ significantly between the centers (Figs. 4, 5, and 6).

Comorbidities

Comorbidities were recorded for all patients. Overall, the incidence of comorbidities for patients with primary RYGB was 87.3 %. The incidence of comorbidities of patients operated on in a cCoR/E was 86.2 %, 87.9 % in cCoC (86.9 % in certified hospitals), and 88.5 % in non-certified hospitals. The incidence of the multiple comorbidities is shown in Tables 1 and 2.

Intraoperative Complication Rates

Overall, the intraoperative complication rates were higher in non-certified hospitals than in certified hospitals (4.8 vs. 1.4 %; $p < 0.001$). Within the certified subgroups, cCoR/E has slightly more intraoperative complication than cCoC (1.6 vs. 1.1 %; $p = 0.025$).

General Postoperative Complication Rates

The highest general postoperative complication rate was detected in non-certified hospitals (8.0 %). In cCoR/E, the general postoperative complication rate was lower than in cCoC (2.7 vs. 7.0; $p < 0.001$). Most complications in cCoC were fever >2 days ($n = 81$, 1.8 %), pulmonary disease ($n = 61$, 1.3 %), and others ($n = 171$, 3.7 %), whereas in cCoR/E the highest complication rates were for others ($n = 75$, 1.2 %), fever >2 days ($n = 64$, 1.1 %), and urinary tract infection ($n = 17$, 0.3 %).

Surgical Postoperative Complication Rates

There was a relevant difference in the total incidence of surgical postoperative complications between patients operated on in cCoR/E compared to cCoC. The surgical complication rate in cCoR/E was 2.7 % in contrast to 6.6 % in cCoC ($p < 0.001$). The rate in non-certified hospitals was higher than in certified hospitals (7.5 vs. 4.4 %; $p < 0.001$).

Further evaluation has shown that especially the leakage rate in RYGB in cCoR/E was 0.9 %, in cCoC 2.2 % (1.5 % in certified hospitals), and in non-certified hospitals 2.8 %.

Thirty-Day Mortality

For RYGB operations recorded in GBSR between 1 January 2005 and 31 December 2013, the 30-day mortality rate was 0.23 % ($n = 31$). The mortality rate was higher in non-certified hospitals than in certified hospitals (0.5 vs. 0.2 %; $p = 0.002$). The mortality rates in cCoC and in cCoR/E also differ (0.3 vs. 0.1 %; $p = 0.22$).

Matched Pair Analysis

To exclude patient- and center-related effects on postoperative complications and perioperative morbidity and mortality, matched pairs analysis by propensity score was performed.

Matched Pairs Analysis of Certified to Non-Certified Hospitals

Out of 3056 RYGB patients in non-certified hospitals, it was possible to select 2772 patients by one-to-two match for 5539 patients (out of 10,666 patients), who underwent RYGB in a certified center. The baseline characteristics were almost exactly the same (Table 3).

For the comparison of certified with non-certified hospitals, we detected a significantly longer operation time at non-certified hospitals (146.5 ± 67.4 min) than in certified hospitals (108.0 ± 49.5 min) ($p < 0.001$). All intra-, general as well as surgical postoperative complication rates were significantly higher in non-certified centers than in certified centers (each $p < 0.001$) (Table 3). These effects also resulted in a significantly higher 30-day mortality rate of 0.43 % ($n = 12$) in non-certified hospitals compared to centers with certification 0.14 % ($n = 8$) ($p = 0.016$). Likewise, the follow-up rate was

Table 2 Distribution of demographic and comorbidity factors as well as complication and mortality rates for competence center vs. reference/excellence center

Variable	Category	Unit	Certified Centers of Competence (N = 4613 patients; N = 27 center)	Certified Centers of Reference/Excellence (N = 6053 patients; N = 10 center)	p value
RYGB per center		Mean/range	170.9/8–577	605.3/14–2750	
RYGB per center per year		Mean	29.0	91.7	
Gender	Male	*N*/%	1053/22.8	1292/21.3	0.067
	Female		3560/77.2	4761/78.7	
Age [years]		Mean/SD	43.2/11.0	41.2/11.0	<.001
BMI [kg/m^2]		Mean/SD	48.6/7.1	47.3/6.9	<.001
Patients with comorbidities	Yes	*N*/%	4053/87.9	5220/86.2	0.014
	No		560/12.1	833/13.8	
Hypertension	Yes	*N*/%	2823/61.2	3218/53.2	<.001
	No		1790/38.8	2835/ 46.8	
Diabetes (total)	Yes	*N*/%	1655/38.8	1785/33.2	<.001
	No		2606/61.1	3587/66.8	
Type 2 insulin dependent diabetes	Yes	*N*/%	597/14.0	485/9.0	<.001
	No		3664/86.0	4887/91.0	
Type 2 non-insulin dependent diabetes	Yes	*N*/%	920/21.6	1214/22.6	0.237
	No		3341/78.4	4158/77.4	
Heart disease	Yes	*N*/%	491/10.6	299/4.9	<.001
	No		4122/ 89.4	5754/95.1	
Pulmonary disease	Yes	*N*/%	1094/23.7	853/14.1	<.001
	No		3519/67.3	5200/85.9	
History of pulmonary embolism	Yes	*N*/%	30/0.7	37/0.6	0.800
	No		4583/99.3	6016/99.4	
Sleep apnea	Yes	*N*/%	1045/22.7	1033/17.1	<.001
	No		3568/77.3	5020/82.9	
Gallstones	Yes	*N*/%	195/4.2	319/5.3	0.013
	No		4418/95.8	5734/94.7	
Gastroesophageal reflux disease	Yes	*N*/%	926/20.1	1355/22.4	0.004
	No		3687/79.9	4698/77.6	
Bone disease	Yes	*N*/%	2119/45.9	1888/31.2	<.001
	No		2494/54.1	4165/68.8	
Smoking	Yes	*N*/%	582/12.6	652/10.8	0.003
	No		4031/87.4	5401/89.3	
Alcoholism	Yes	*N*/%	103/2.2	73/1.2	<.001
	No		4510/97.8	5980/98.8	
Intraoperative complications	Yes	*N*/%	49/1.1	95/1.6	0.025
	No		4564/98.9	5958/98.4	
General postoperative complications	Yes	*N*/%	323/7.0	165/2.7	<.001
	No		4290/93.0	5888/97.3	
Surgical postoperative complications	Yes	*N*/%	303/6.6	164/2.7	<.001
	No		4310/93.4	5889/97.3	
Leakage at GJA	Yes	*N*/%	101/2.2	54/0.9	<.001
	No		4512/97.8	5999/99.1	
Sepsis	Yes	*N*/%	26/0.6	9/0.1	<.001
	No		4587/99.4	6044/99.9	
Peritonitis	Yes	*N*/%	44/1.0	16/0.3	<.001
	No		4569/99.0	6037/99.7	
Bleeding with reoperation	Yes	*N*/%	43/0.9	35/0.6	0.033
	No		4570/99.1	6018/99.4	
30-day mortality	Yes	*N*/%	12/0.3	5/0.1	0.022
	No		4580/99.7	6038/99.9	

No information's on age for six and on BMI for three patients

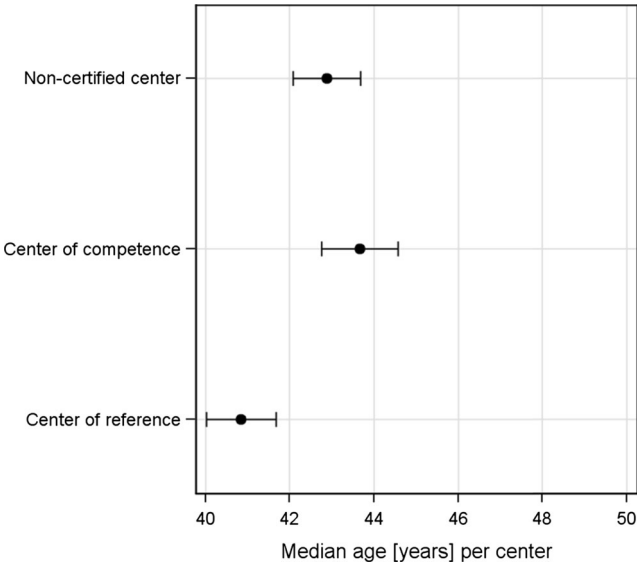

Fig. 2 Mean and 95 % confidence limits of median age per center for accredited hospital types

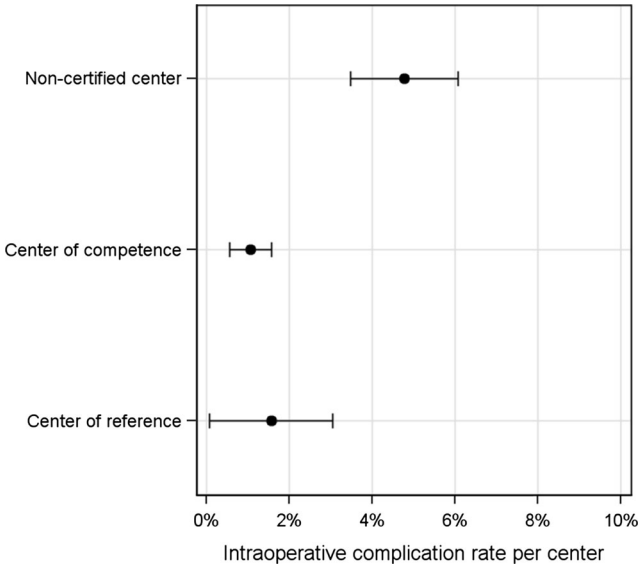

Fig. 4 Mean and 95 % confidence limits of intraoperative complication rate per center for hospital volume

statistically significantly higher in certified centers at 59.5 % compared to non-certified hospitals at 34.3 % ($p < 0.001$).

Matched Pairs Analysis of cCoC and cCoR/E

Analysis based on 1:1 propensity score matching produced 3880 pairs of RYGB patients. The baseline characteristics for both groups were almost exactly the same (Table 4).

The mean operation time was significantly shorter in cCoR/E 95.6 ± 47.3 min vs. 124.5 ± 49.6 min in cCoC ($p < 0.001$), whereas the intraoperative complication rate was significantly lower in certified cCoC than in cCoR/E (1.16 vs. 1.80 %; $p = 0.019$). The general postoperative complication rates as well as surgical postoperative complication rates were significantly lower in centers with higher experience. In particular, the leakage rate at the gastrojejunal anastomosis was significantly lower in the hospitals with the higher surgical volume (2.19 vs. 1.03 %; $p < 0.001$ %). There was no significant statistical difference in the mortality rate of 0.21 % ($n = 8$) in cCoC and 0.10 % ($n = 4$) in cCoR/E ($p = 0.266$).

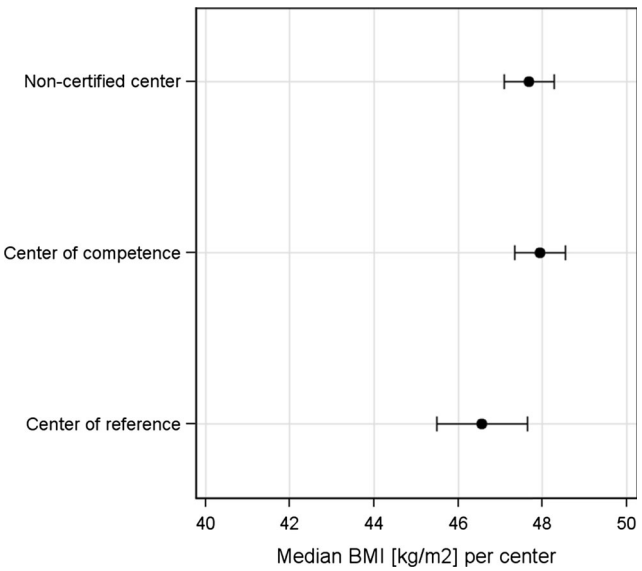

Fig. 3 Mean and 95 % confidence limits of median BMI per center for accredited hospital types

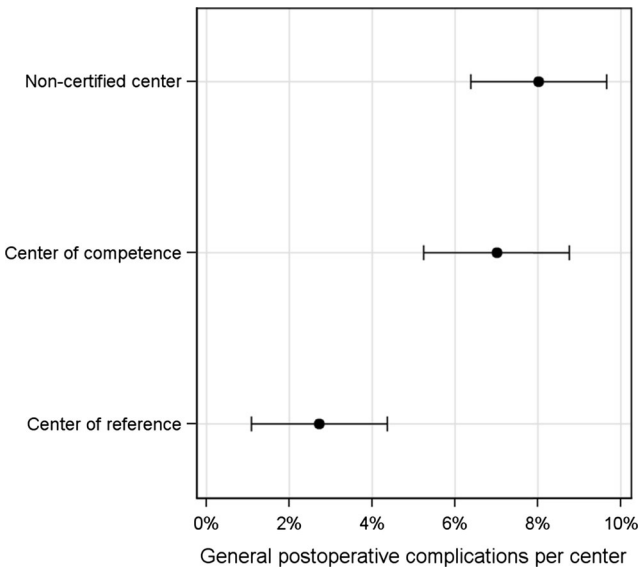

Fig. 5 Mean and 95 % confidence limits of general postoperative complication rate per center for hospital volume

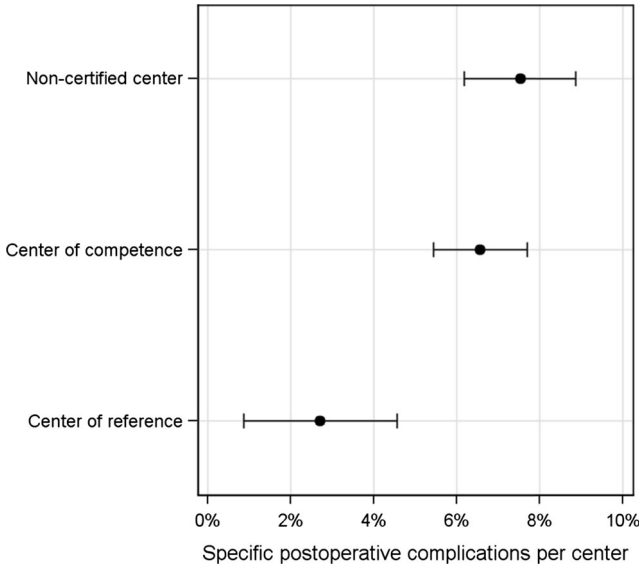

Fig. 6 Mean and 95 % confidence limits of specific postoperative complication rate per center for hospital volume

Discussion

In this study, the GBSR data were analyzed to evaluate the postoperative outcome in patients operated on in hospitals without certification with a mean number of RYGB per year of 12, in cCoC with 29, and in cCoR/E with 92. Matched pairs analysis based on propensity score was performed for specific evaluation and to compensate for the inhomogeneity of patient-related parameters.

A study with more than 32,500 patients operated on in accredited and non-accredited hospitals had concluded that there was evidence of a volume-outcome relationship. That relationship appeared linear with no clear point that maximally differentiated high- and low-volume centers [9].

A study of patients in Pennsylvania detected a poorer outcome for RYGB patients if the surgical volume was between 10 and 50 operations per year in a low-volume hospital [10].

These data were supported by the investigations by Zevin et al. [6]. Analysis has shown that the annual surgical volume was strongly associated with improved patient outcome [6]. These findings were supported by the investigations by Flum et al. [11] who analyzed the nationwide Medicare database of 40,030 patients between 2004 and 2008. The investigations had identified a decreasing 90-day mortality rate from 1.5 to 0.7 % [11]. These data are comparable with the significantly lower mortality rate after RYGB in certified centers compared with in non-certified hospitals in Germany. Data on 35,284 patients after bariatric surgery identified a significantly lower in-hospital mortality rate of 0.06 % in accredited vs. 0.21 % in non-accredited centers [12]. Investigations on the association between hospital volume and patient outcome performed by Courcoulas et al. [10] also reported a significantly different adjusted outcome with mortality rates of 3.52 vs. 0.53 % for low- and high-volume hospitals [10]. These investigations were supported by the data of Torrente et al. [13]. That study had shown that the 30-day mortality rate as well as the in-hospital mortality rate was lower in high-volume hospitals and when the operation was performed by high-volume surgeons [13]. The evaluated GBSR data have also shown a significantly lower 30-day mortality in certified centers (0.14 %) compared with non-certified hospitals (0.43 %).

Of importance for patient outcome and mortality are the intraoperative as well as the postoperative complications. Evaluation of GBSR data has already shown that the perioperative complication rates influence the mortality rate significantly. Low-volume centers with low complication rates are described by Gould et al. in the literature [9]. These data have shown that there may be low-volume centers with extremely

Table 3 Propensity score matching (1:2 match) of non-certified hospitals with certified bariatric centers

			Non-certified hospitals (N = 3056)	Certified centers (N = 10,666)	p value
Matched parameters	Matched pairs	[n]	2772	5539	
	Female	[%]	75.6	75.2	
	Age—mean	[years]	42.8	42.8	
	BMI—median	[kg/m^2]	47.4	47.6	
	Patients with comorbidities	[%]	87.3	87.4	
Outcome	Operation time	[min]	146.5	108.0	<0.001
	Intraoperative complication rate	[%]	5.19	1.62	<0.001
	General postoperative complication rate	[%]	7.90	5.13	<0.001
	Surgical postoperative complication rate	[%]	7.58	4.73	<0.001
	Leakage at GJA	[%]	2.89	1.86	0.003
	30-day mortality rate	[%]	0.43	0.14	0.016
	Follow-up rate	[%]	34.3	59.5	<0.001

Table 4 Propensity score analysis of accredited centers with 50 to 100 procedures yearly vs. that of centers with more than 100 procedures per year

			Certified Centers of Competence ($N = 4613$)	Certified Centers of Reference/Excellence ($N = 6053$)	p value
Matched parameters	Matched pairs	[n]	3880	3880	
	Female	[%]	77.6	77.9	
	Age—mean	[years]	42.8	42.9	
	BMI—median	[kg/m^2]	47.5	47.6	
	Patients with comorbidities	[%]	85.6	85.7	
Outcome	Operation time	[min]	124.5	95.6	<0.001
	Intraoperative complication rate	[%]	1.16	1.80	0.019
	General postoperative complication rate	[%]	6.98	2.99	<0.001
	Surgical postoperative complication rate	[%]	6.44	2.84	<0.001
	Leakage at GJA	[%]	2.19	1.03	<0.001
	30-day mortality rate	[%]	0.21	0.10	0.266
	Follow-up rate	[%]	61.7	61.1	0.639

low complication rates and high-volume centers with elevated rates of complications [9].

The complication rates adjusted for age, gender, and comorbidities in the study by Encinosa et al. [14] were significantly different for high- (>521 procedures per year) vs. low-volume (<160 operations per year) centers [14].

The systematic review by Zevin et al. [6] has shown that the evidence for annual surgical volume strongly points towards an association with improved patient outcome [6]. The study by Weller et al. [15] found that patients in each of the lower hospital volume categories were more likely to be readmitted compared with the highest volume category (>300 procedures per year) [15].

The evidence for the association between annual hospital volume and patient outcome is also in favor of improved outcomes in higher volume hospitals in the Study by Birkemeyer et al. [3].

But the data of Birkmeyer et al. [3] have also shown that the US Centers of Excellence were not safer than non-accredited hospitals [3]. The drawback of that study was that it entailed only an analysis of several statuses of hospitals without elimination of patient-related factors like age, gender, BMI, and comorbidities. Investigations by Morton et al. [16] of data on 117,478 patients operated on in 2010 have shown a significantly improved outcome for patients operated on in accredited centers (complication rate was 11.3 vs. 12.3 %; $p = 0.001$; mortality rate 0.07 vs. 0.13 %; $p = 0.019$) [16]. The shortcoming of that study was that it had not evaluated the effect of BMI, age, gender, and number of comorbidities.

In addition to exclusion of these important factors influencing the perioperative morbidity and mortality, there is a need for discussion of how to improve the outcome. Data from the Scandinavian bariatric surgery registry with 22,327 patients with RYGB have demonstrated that preoperative weight reduction reduced the relative risk of complications to between 11 and 24 % [17]. These data support our investigations indicating that the outcome is influenced not only by the hospital volume. The rate of comorbidities, preoperative BMI as well as age also influences the perioperative complication rate. These findings were also underlined by the paper by Sanni et al. [18] showing an increase of one point in the complication rate for every year of age and of two points for every point of BMI [18].

The GBSR data support these investigations, especially for the intraoperative complication rate during RYGB.

The findings based on the GBSR data presented here and in the literature review attest to the importance of regionalization of bariatric care to accredited or certified bariatric centers. A publication by Gebhardt et al. [19], in particular, has shown a reduction in the mortality rates in accredited centers (0.17 %) vs. non-accredited hospitals (0.45 %) [19]. Regionalized care has the advantage of experienced surgeons and staff caring for bariatric and obesity surgery patients. The benefits translated into reduced complication rates, optimized management, and improved patient outcome. Apart from the hospital volume, there are important factors like age, gender [20], BMI [21], and incidence of comorbidities which influence the perioperative complication rates.

In conclusion, the GBSR data as well as data in the literature were analyzed to ascertain the effect of centers on patient outcome in obesity and metabolic surgery. We found evidence for improved patient outcome after RYGB in certified centers in Germany in comparison with non-certified hospitals. Higher annual case volumes are associated with an improved outcome for patients with RYGB.

Factors which affect perioperative morbidity but cannot be modified, e.g., age, gender, and comorbidity, should promote

the choice of low-risk procedures. Those risk factors that can be modified should be minimized prior to surgery (BMI, sleep apnea, diabetes control).

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Conflict of Interest The German Nationwide Survey on Bariatric Surgery is supported by the Ministry of Research and Education Germany (BMBF) grant number 01GI1124. The responsible investigator is Christine Stroh.

All authors confirm that there are no links to companies whose products are mentioned in the article or to companies marketing a competing product. The topic is presented in an independent light, and the information outlined is product neutral.

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