Obesity Surgery (2021) 31:4511–4518
https://doi.org/10.1007/s11695-021-05640-2

ORIGINAL CONTRIBUTIONS

Impact of the COVID-19 Pandemic and Lockdown on Gastric Bypass Results at 1-Year Follow-up

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Received: 25 May 2021 / Revised: 22 July 2021 / Accepted: 22 July 2021 / Published online: 10 August 2021

Abstract

Purpose The COVID-19 pandemic caused a lockdown in many countries, which induced negative dietary habits and sedentary behavior. Studies suggest that weight loss of patients undergoing bariatric surgery was equally affected. The aim was to evaluate the impact of COVID-19 on weight loss, obesity-related comorbidities, and nutritional status at 1-year follow-up after gastric bypass (GB).

Methods Retrospective observational case–control study of patients undergoing primary GB in a tertiary referral Belgian center. COVID-19 period group was composed by those whose 1-year postoperative period was affected by the COVID-19 pandemic and lockdown: from October 1, 2019, to March 31, 2020. The control group was composed of patients operated from October 1, 2018, to March 31, 2019. Electronic clinical records were reviewed searching: baseline characteristics, weight and comorbidities evolution, and biochemical values.

Results A total of 47 patients in the COVID-19 period group and 66 in the non-COVID-19 period group were analyzed. There were no significant differences in baseline characteristics. A reduced weight loss was observed at 1-year follow-up, in terms of percentage of excess weight loss (%EWL) (82.4% [SD: 21.6] vs. 82.4% [SD: 21.6]; *p*: 0.043) and body mass index (BMI) (27.8 kg/m^2 [IQR: 25.8–30.0] vs. 26.2 kg/m^2 [IQR: 24.6–28.6]; *p*: 0.029) for COVID-19 period group vs. non-COVID-19 period group, respectively. There was a similar reduction of obesity-related comorbidities, without clinically significant differences in the nutritional follow-up.

Conclusion The COVID-19 pandemic and lockdown had an impact on weight loss at 1-year follow-up after gastric bypass.

Keywords Gastric bypass · Bariatric surgery · Obesity · Weight loss · COVID-19 · Coronavirus

Introduction

Background

Obesity is a chronic disease linked to the development of multiple comorbidities, whose prevalence is increasing worldwide [1]. Bariatric surgery allows an effective weight loss with substantial reduction or improvement of obesity-related comorbidities: hypertension, diabetes, hyperlipidemia, and obstructive sleep apnea [2]. The first year after bariatric surgery represents the key to success, as it is when most of the patients' excess weight loss occur [3, 4]. Besides, patients with a reduced weight loss are more prone to weight regain during long-term follow-up [4].

Coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), began in early December 2019 and rapidly became an international

Key Points
- The COVID-19 lockdown reduced the weight loss at 1-year follow-up after gastric bypass.
- There was a similar reduction of obesity-related comorbidities.
- There was no clinically significant differences in the nutritional follow-up.

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public health emergency [5]. Europe was severely affected by COVID-19, with many countries imposing a lockdown between March 2020 and May 2020 to reduce COVID-19 transmission [6]. These restrictions caused an increase on sedentary behavior [7] and negative changes in dietary habits [8], which affected the weight loss of patients undergoing bariatric surgery just before the lockdown [9–11]. Furthermore, hospital follow-up visits were unrecommended during this period [12], while some patients did not attend due to fear of being infected [10]. Even if these visits were substituted with telemedicine when possible, we hypothesize if it could have an impact on nutritional follow-up, necessary to avoid macro- or micronutritional deficiencies after bariatric surgery [13].

Objective

The primary aim of this study was to evaluate the impact of the COVID-19 pandemic and lockdown on weight loss during the first postoperative year after gastric bypass. Secondary outcomes were to evaluate the impact on obesity-related comorbidities and nutritional follow-up.

Methods

This article was written according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies [14].

Study Design

Retrospective observational case–control study.

Setting and Participants

We included all consecutive patients who underwent a primary gastric bypass in our institution (Centre Hospitalier Universitaire Saint-Pierre) a tertiary referral center from Belgium and whose 1-year postoperative period was affected by the COVID-19 pandemic and lockdown: from October 1, 2019, to March 31, 2020 (COVID-19 period). The control group was composed of patients who underwent a primary GB from October 1, 2018, to March 31, 2019, and were unaffected by the COVID-19 pandemic and lockdown (non-COVID-19 period). GB was considered for patients with BMI $\geq$ 40 kg/m^2 or BMI $\geq$ 35 kg/m^2 with associated comorbidities [15]. All patients were older than 18 years.

Patients with previous bariatric surgery, those who refused the follow-up or who did not attend the 1-year visit, were excluded.

The study was approved by the Institutional Clinical Research Ethics Committee.

Intervention

All patients underwent a laparoscopic Roux-en-Y gastric bypass. A 30-ml gastric pouch was confected with a stapling device guided by a 34-French orogastric tube. Then, 60–80 cm of small bowel from the angle of Treitz were measured for the creation of the biliopancreatic limb. A gastrojejunal anastomosis was performed side to side using a linear stapling machine and closure of the openings by two sutures of 2/0 polydiaxone. Posteriorly, 80–100 cm of small bowel were measured for the confection of the alimentary limb. A jejunojejunal anastomosis was performed side to side using a linear stapling machine and closure of the openings by two sutures of 2/0 polydiaxone. Finally, the small bowel segment between the gastrojejunal and jejunojejunal anastomosis was sectioned with a linear stapling machine, and the mesenteric defect was closed.

Variables

Data were extracted from the medical records. Preoperative variables were sex, age (years), weight, body mass index (BMI), comorbidities (hypertension, type 2 diabetes, and obstructive sleep apnea), American Society of Anesthesiologists classification, and biochemical values: total proteins, albumin, vitamin D, and zinc. Early postoperative variables were hospital stay and major postoperative complications, defined as complications grade III or IV of the Clavien-Dindo classification [16].

Follow-up variables were evolution of BMI during follow-up visits, percentage of total weight loss (%TWL) at 1 year, percentage of excess weight loss (%EWL) at 1 year, reduction of comorbidities at 1 year, reduction of pharmacological treatment, and biochemical values at 1 year. %TWL was calculated as (weight loss / initial weight) x 100 and %EWL as [weight loss / (initial weight—ideal body weight)] x 100, being the ideal body weight the weight for a BMI equal to 25 kg/m^2. Hypertension remission was considered with a normal blood pressure in the absence of antihypertensive treatment. Type 2 diabetes remission was considered with a fasting plasma glucose level $\leq$ 126 mg/dl in the absence of hypoglycemic agents. Obstructive sleep apnea remission was considered with improved sleep quality reported by the patient in patients without continuous positive airway pressure (CPAP) treatment or cessation of the CPAP use after pneumologist consultation.

Follow-up

Patients were discharged home in the absence of postoperative complications, usually at postoperative day 2. Then, a multidisciplinary follow-up was initiated by the team of surgeons, endocrinologist, dietitians, and psychologists, with regular visits at 10 days, 1 month, 3 months, 6 months, and 1 year.

Study Size

We calculated our study size based on the percentage of excess BMI loss reported by Vitiello et al. [10], which was 77.1% (SD: 18.9) for the non-COVID-19 period vs. 62.3% (SD: 18.9) in the COVID-19 period. Therefore, for a two-tailed analysis with a statistical power of 80%, and assuming an alpha error of 0.05, a minimum of 27 patients in each period were needed to replicate their results.

Statistical Analysis

Categorical variables were described as numbers and percentages. Quantitative variables were described with mean and standard deviation (SD) if they followed a normal distribution and with median and interquartile range (IQR) if they followed a non-normal distribution. The distribution of the variables was determined through the Kolmogorov–Smirnov test. To evaluate the differences between both groups, categorical variables were analyzed with the $\chi 2$ test, and quantitative variables were analyzed with Student's t-test if they followed a normal distribution or with the Mann–Whitney U test if they followed a non-normal distribution. A p-value < 0.05 was considered statistically significant. The analysis was performed with SPSS Statistics 23® (IBM, Chicago, IL).

Results

Participants

A total of 54 patients underwent a primary GB in the COVID-19 period, from October 1, 2019, to March 31, 2020. In this group, seven patients were excluded from analysis: one patient refused to continue the follow-up, and six of them did not attend the 1-year visit. Therefore, 47 patients were suitable for analysis. In the non-COVID-19 group, 70 patients underwent a primary GB from October 1, 2018, to March 31, 2019. In this control group, four patients were excluded from analysis: one patient refused to continue the follow-up, and three of them did not attend the 1-year visit. Thus, 66 patients were suitable for analysis (Fig. 1).

Baseline Characteristics

There were no statistically significant differences in the demographic baseline characteristics. Most patients were female, 72.3% (34/47) in the COVID-19 period and 81.8% (54/66) in the non-COVID-19 period (p: 0.232), with a mean age of 40.6 years (SD: 12.6) in the COVID-19 period and 42.6 years (SD: 13.5) in the non-COVID-19 period (p: 0.438). The median BMI was 40.8 kg/m^2 (IQR: 38.9–44.5) for the COVID-19 period and 40.3 kg/m^2 (IQR: 38.5–42.5) for the non-COVID-19 period (p: 0.200). The most frequent comorbidity was obstructive sleep apnea (40.4% [19/47] vs. 50% [33/66]) followed by hypertension (31.9% [15/47] vs. 30.3% [20/66]) and type 2 diabetes (29.8% [14/47] vs. 24.2% [16/66]) in COVID-19 and non-COVID-19 period groups, respectively. Most patients were ASA II: 89.4% (42/47) in the COVID-19 period and 83.3% (55/66) in the non-COVID-19 period (p: 0.562).

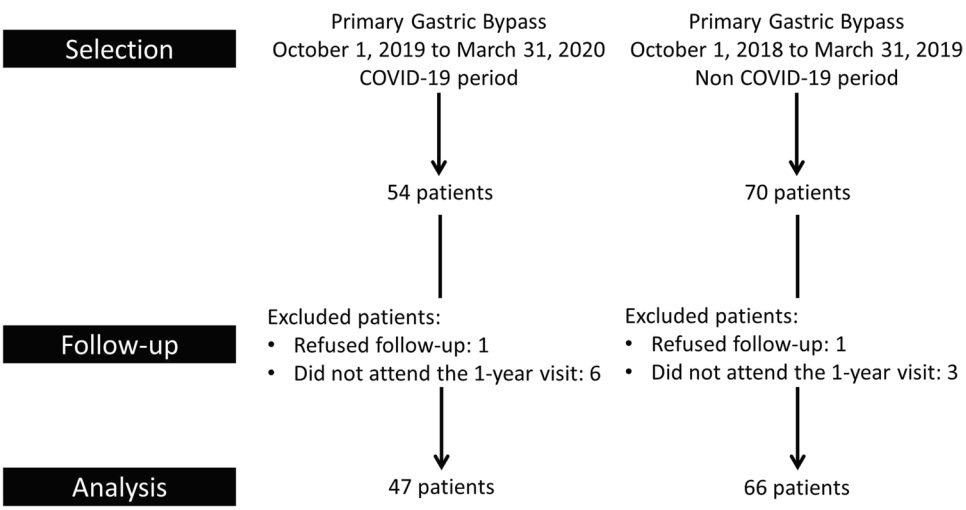

Fig. 1 Flowchart of patients

There were not statistically significant differences in preoperative biochemical values of total proteins, albumin, and zinc. Vitamin D values were statistically significantly lower in patients of the COVID-19 period (13.8 μg/l [IQR: 10–19.9] vs. 16.8 μg/l [12.9–23.7], *p*: 0.038).

After all patients underwent a GB, the median postoperative stay was 2 days, without differences between groups. There were not statistically significant differences in the presence of major complications between groups, which affected 6.4% (3/47) of patients of the COVID-19 period and 3% (2/66) of patients of the non-COVID-19 period (*p*: 0.393). Baseline characteristics at the moment of GB are shown in Table 1.

Follow-up and Evolution of Weight Loss

There were not statistically significant differences in the degree of compliance of follow-up between groups. In the COVID-19 period group, there was a 97.9% (46/47), 93.6% (44/47), and 100% of attendance in 3 months, 6 months, and 1 year visit, respectively, compared to a 100% of attendance in the non-COVID-19 period group (*p*: 0.416, 0.069, 1.000). There was a 25.5% rate (12/47) of telephonic 3 months of consultations and a 6.5% rate of telephonic 6 months of consultations in the COVID-19 period groups, while all consultations of the non-COVID-19 period and all 1-year visits were face-to-face.

During the first postoperative year, there was a progressive reduction of BMI in both groups. There were no differences in BMI at 3- and 6-month follow-up, and no differences were observed including telephonic visits or considering only face-to-face visits. However, BMI was statistically significantly higher in patients of the COVID-19 period after 1 year of follow-up (27.8 kg/m^2 [IQR: 25.8–30.0] vs. 26.2 kg/m^2 [24.6–28.6], *p*: 0.029). There was a discrete lower %TWL in the COVID-19 period (mean: 32% [SD: 7.1]) than in the non-COVID-19 period (34.1% [SD: 7.5]) although the differences were not statistically significant (*p*: 0.122). There were statistically significant differences in terms of %EWL, which was lower in the COVID-19 period (mean: 82.4% [SD: 21.6]) compared to that in the non-COVID-19 period (91.7% [SD: 24.5]) (*p*: 0.043). The evolution of weight loss is represented in Fig. 2 and resumed in Table 2.

Evolution of Secondary Outcomes

There was a significant reduction in all patients' comorbidities at 1-year follow-up face-to-face visits in both groups. Comparison between COVID-19 and non-COVID-19 period groups at 1-year follow-up demonstrated no statistically significant differences in the evolution of patients'

Table 1 Baseline characteristics

	COVID-19 period 47 patients	Non-COVID-19 period 66 patients	
	n (%) Median (IQR)	*n* (%) Median (IQR)	*p*-value
Sex	13:34	12: 54	0.232
Male: female	(27.7%: 72.3%)	(18.2%: 81.8%)	
Age (years) *	40.6 (12.6)	42.6 (13.5)	0.438
Weight (kg)	114 (103.9–128)	110.7 (100.6–120.1)	0.135
BMI (kg/m^2)	40.8 (38.9–44.5)	40.3 (38.5–42.5)	0.200
HTA	15 (31.9%)	20 (30.3%)	0.855
Type 2 diabetes	14 (29.8%)	16 (24.2%)	0.511
Obstructive sleep apnea	19 (40.4%)	33 (50%)	0.314
ASA classification			
I	1 (2.1%)	1 (1.5%)	0.562
II	42 (89.4%)	55 (83.3%)	
III	4 (8.5%)	10 (15.2%)	
Preoperative biochemical values			
Total proteins (g/dl)	7.4 (7.0–7.6)	7.5 (7.2–7.8)	0.128
Albumin (g/dl)	4.4 (4.2–4.5)	4.4 (4.2–4.5)	0.731
Vitamin D (μg/l)	13.8 (10–19.9)	16.8 (12.9–23.7)	0.038
Zinc (μg/dl)	74 (60.5–88.5)	73 (66–84)	0.984
Hospital stay (days)	2 (2—2)	2 (2–2.3)	0.721
Major postoperative complications (Clavien-Dindo III–IV)	3 (6.4%)	2 (3%)	0.393

* Mean (SD)

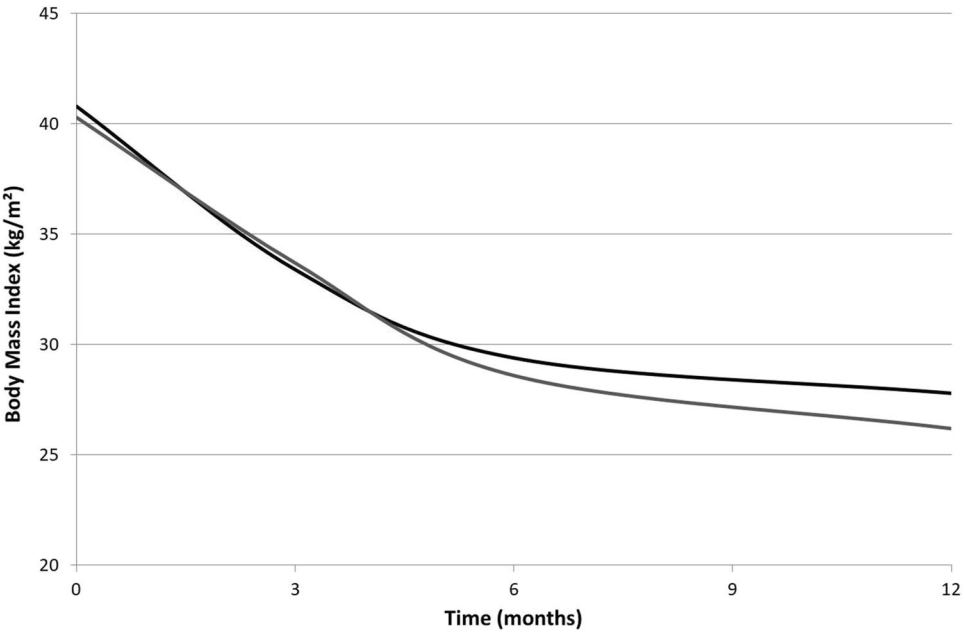

Fig. 2 Evolution of BMI

comorbidities. Obstructive sleep apnea affected 19.1% (9/47) of patients in the COVID-19 period group compared to 18.2% (12/66) of the non-COVID-19 period group (*p*: 0.896); hypertension affected 23.4% (11/47) of patients vs. 15.2% (10/66) (*p*: 0.266), while type 2 diabetes affected 10.6% (5/47) of patients vs. 10.6% (7/66) (*p*: 1.000) (Table 3). In both groups, patients benefited from a reduction of pharmacological treatment, which was achieved in 27.7% (13/47) of patients in the COVID-19 period group compared to 19.7% (13/66) of the non-COVID-19 period group (*p*: 0.322).

There were not statistically significant differences in 1-year biochemical values of total proteins, albumin, and vitamin D between groups. In patients of the COVID-19 period, zinc values (87.5 µg/dl [IQR: 74–112.1] vs. 70.5 µg/l [61–82], *p*: 0.001) were statistically significantly higher compared with patients of non-COVID-19 period.

Discussion

There was a reduction in the excess weight loss of patients intervened prior to the pandemic (mean: 82.4% [SD: 21.6]) compared with patients of the non-COVID-19 period (91.7% [SD: 24.5]). This confirms the results obtained by El Moussaoui et al. [9] for sleeve gastrectomy in Belgium at 1-year follow-up, where patients intervened before the pandemic outbreak had a %EWL of 67.6% (SD: 23.5) while patients of the control group had a %EWL of 78.3% (SD: 27.2). Similar results were attained by Vitiello et al. [10] for sleeve gastrectomy and one anastomosis gastric bypass in Italy at 6-month follow-up, with an excess of BMI loss of patients in the COVID-19 period of 62.3% (SD: 18.9) vs. 77.1% (SD: 18.9) in the non-COVID-19 period. Differences were also detected by Conceiçao et al. [11] for sleeve and GB at 3 years of follow-up,

Table 2 Evolution of weight loss

	COVID-19 period 47 patients	**Non-COVID-19 period 66 patients**	
	n (%) Median (IQR)	*n* (%) Median (IQR)	*p*-value
BMI (kg/m^2) at 3 months	33.4 (30.5–36.8)	33.7 (30.9–35.2)	0.360
BMI (kg/m^2) at 3 months of face-to-face visits	33.3 (31.2–36.6)	33.7 (30.9–35.2)	0.370
BMI (kg/m^2) at 6 months	29.4 (26.4–35.0)	28.6 (26.6–31.2)	0.349
BMI (kg/m^2) at 6 months of face-to-face visits	29.2 (26.1–35.2)	28.6 (26.6–31.2)	0.382
BMI (kg/m^2) at 1 year	27.8 (25.8–30.0)	26.2 (24.6–28.6)	0.029
%TWL at 1 year *	32 (7.1)	34.1 (7.5)	0.122
%EWL at 1 year *	82.4 (21.6)	91.7 (24.5)	0.043

* Mean (SD)

%TWL Percentage of total weight loss

Table 3 Evolution of secondary outcomes at 1-year follow-up

	COVID-19 period 47 patients	Non-COVID-19 period 66 patients	
	n (%) Median (IQR)	*n* (%) Median (IQR)	*p*-value
HTA	11 (23.4%)	10 (15.2%)	0.266
Type 2 diabetes	5 (10.6%)	7 (10.6%)	1.000
Obstructive sleep apnea	9 (19.1%)	12 (18.2%)	0.896
Reduction of pharmacological treatment	13 (27.7%)	13 (19.7%)	0.322
Biochemical values at 1 year			
Total proteins (g/dl)	6.9 (6.4–7.5)	6.9 (6.6–7.3)	0.747
Albumin (g/dl)	4.3 (4.2–4.5)	4.3 (4.1–4.4)	0.134
Vitamin D (µg/l)	35.2 (27.4–46.8)	31.1 (25–38.8)	0.060
Zinc (µg/dl)	87.5 (74–112.1)	70.5 (61–82)	0.001

with a higher percentage of weight loss regain in patients affected for the lockdown (21.71% [SD: 16.36] vs. 14.07% [SD: 16.36]). Therefore, these results suggest that the reduction in weight loss was a constant of all bariatric surgeries, irrespective of the surgical technique.

The reasons behind these differences might be the result of unhealthy dietary habits: increased number of meals, reduction of fresh products intake, and increased snack and alcohol consumption [17]. Moreover, there was a reduction in physical activity [7, 17], and both factors resulted in weight gain. These negative changes were also observed in patients with history of bariatric surgery [8, 18–20], who additionally had to cope with a negative emotional state [8], increasing vulnerability [21], and symptoms of anxiety, loneliness, and depression [20].

Despite the differences observed in weight loss, patients' comorbidities at 1-year follow-up were significantly reduced, without statistically significant differences between groups. This supports the results observed by El Moussaoui et al. [9] and Vitiello et al. [10]. Therefore, irrespective of the COVID-19 pandemic and lockdown, bariatric surgery remains an effective treatment against diabetes [2, 3, 22], hypertension [2, 3], and obstructive sleep apnea [2, 3, 23]. Moreover, bariatric surgery has been marked as a protective factor against COVID-19 with lower hospital admission rate, reduced intensive care unit admission [24], mechanical ventilation, or exitus [25]. Considering the improvement on obesity comorbidities, all bariatric procedures cancelled or delayed during the COVID-19 pandemic should be restarted as soon as possible [26].

Regarding the impact of COVID-19 pandemic and lockdown on nutritional follow-up, our study did not observe clinically relevant significant differences. Preoperatively, median vitamin D values were under the 20 µg/l reference limit, with lower values in the COVID-19 period group. Vitamin D is the most common micronutrient preoperative deficiency but can be reduced with appropriate postoperative supplementation [27]. In our study, at 1-year follow-up, median vitamin D values were similar between groups and within the normal range (20–50 µg/l). Zinc is an essential micronutrient required for growth and adequate function of the immune system [28], with monitoring and supplementation required after GB [29]. In our study, preoperative zinc values were similar, but there was a statistically significant difference on postoperative values. They were higher in the COVID-19 group, although they remained within the standard range (66–110 µg/dl). No further explanation could be proposed to this outcome due to the retrospective design of the study.

A strength of the study was an adequate follow-up period, which allowed to achieve differences in postoperative BMI. For example, a 3-month follow-up case–control study of patients undergoing sleeve gastrectomy performed by Ruiz de Angulo et al. [30] did not demonstrate difference between groups. A limitation of our study was a possible measurement bias at 3- and 6-month telephonic follow-up of the COVID-19 period group, since self-reported weight tends to be lower than consultation measures [31]. However, no differences were observed analyzing only the patients with face-to-face visits.

To conclude, further studies should evaluate the optimal measures to improve the weight loss of patients intervened immediately prior to the COVID-19 pandemic and long-term outcomes of the impact of COVID-19 on bariatric surgery populations.

Conclusion

The COVID-19 pandemic and lockdown had an impact on weight loss at 1-year follow-up after gastric bypass, with patients' having a higher BMI and a reduced percentage of excess weight loss. There was a significant reduction of patients' comorbidities (T2D, HTA, and OSA) which was

similar between groups, without clinically significant differences in the nutritional follow-up.

Consent to Participate

Informed consent does not apply.

Declarations

Statement of Human and Animal Rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Research Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study, formal consent is not required.

Conflict of Interest The authors declare no competing interests.

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