

Single Anastomosis Gastric Bypass—Comparative Short-Term Outcome Study of Conversional and Primary Procedures

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Abstract

Background Single anastomosis gastric bypass (SAGB) has been established as a safe and effective bariatric procedure. SAGB has also been suggested as a conversion option from other procedures, but so far not extensively explored in that direction.

Methods The study retrospectively reviewed and analyzed 154 consecutive SAGB procedures, including 48 conversional SAGB (cSAGB) and 106 primary SAGB (pSAGB). Preoperative physical dimensions and perioperative complications were obtained. Patients were followed 1, 3, and 6 months postoperatively, with weight measurements compared between groups.

Results Operative times were longer in the cSAGB group but length of hospital stay was the same for both groups. Sixty-five percent of the cSAGB group had adjustable banding as a primary operation, and 94 % opted for conversion due to insufficient weight loss or regain thereof. Follow-up data availability was 98, 82, and 79 % for the three checkpoints. Three and 6 months postoperatively, cSAGB had inferior mean excess weight loss (EWL) compared to pSAGB, though

both groups were successful after 6 months (mean EWL >50 %). Body mass index loss was significantly higher for pSAGB for the first postoperative 3 months. Low complication rates in both groups precluded statistical comparison in that respect.

Discussion Initial weight loss after conversional SAGB is inferior to primary SAGB after 6 months. The observed safety of cSAGB is comparable to previous evidence for this procedure in the conversional settings.

Conclusion SAGB may be considered as a safe and effective conversional procedure, but not as effective as pSAGB for initial weight loss.

Keywords Obesity · Single anastomosis gastric bypass · Secondary procedure · Conversion

Introduction

Secondary bariatric surgery, either revision of the original procedure or conversion to a different operation, is becoming a common practice in bariatric centers [1]. As many as 15 % of bariatric procedures are secondary and usually performed for several indications, among which are insufficient weight loss and intolerance of, or complications associated with, the primary bariatric operation [1–3]. Countering obesity is a long-term challenge, requiring a longstanding effort from both patients and caregivers of all disciplines. This notion gives rise to secondary bariatric surgery as an approach to consider in such circumstances. Such procedures impose, however, greater risk for perioperative and long-term postoperative adverse events [1, 4–7]. Careful consideration and meticulous technique are required for choosing and performing the secondary procedure, in order to minimize these risks.

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Single anastomosis gastric bypass (SAGB) has been increasingly performed in the last 15 years and shown to be a safe and effective bariatric procedure [8]. Although well-established as a primary procedure [9], several authors have also reported experience with secondary SAGB [10–14]. Some have touted SAGB as a technically preferable approach in these circumstances. The longer gastric pouch of SAGB, when compared to standard Roux-en-Y gastric bypass, facilitates an easier reach of the jejunum to the gastrojejunostomy, relieving possible tension and subsequent compromise of the anastomosis [10, 11]. As in most reoperative bariatric surgeries, secondary SAGB demonstrates greater morbidity when compared to primary SAGB [10, 15].

The objective of this study was to evaluate outcomes of conversional SAGB (cSAGB), performed in our institution for various indications. These were compared to outcomes of primary SAGB (pSAGB) operations performed during the same period by the same surgeons.

Materials and Methods

We retrospectively reviewed prospectively collected data of all patients who underwent SAGB in our institution, between June 2015 and February 2016. All procedures were performed by the authors (A.R., N.S., D.G.), who are experienced bariatric surgeons. Preoperative evaluation: Each patient undergoing bariatric surgery was evaluated before the operation by a multidisciplinary team. All underwent fluoroscopic upper gastrointestinal evaluation and conversional cases underwent endoscopic evaluation as well. Weight loss history was obtained for conversional cases only. The study population was divided into primary and secondary procedures. Perioperative data collected included intraoperative estimated blood loss (EBL), operative times, and length of hospital stay (LOS). Outcomes were compared between the groups as assessed during postoperative follow-ups. The follow-up assessments were performed 1, 3, and 6 months postoperatively.

Surgical Technique Four laparoscopic ports were used. When relevant, reversal of the previous operation was performed (see below). A long and narrow gastric pouch was fashioned alongside the lesser curvature beginning at the incisura angularis with linear staplers (Echelon 60 Endopath Stapler®, Ethicon Endosurgery, Cincinnati, OH, or Endo GIA™ Staplers with Tri-Staple™ reloads, Covidien, Norwalk, CT). A gastrojejunal anastomosis to this pouch was created 150–200 cm from the ligament of Treitz, again with a linear stapler, fired at 4.5 cm with hand-sewn, single-layer continuous 2/0 polyglactin braided suture (Vicryl®, Ethicon Endosurgery, Cincinnati, OH) over a 34F bougie. A suture was placed to “hitch up” the loop between the pouch and the afferent loop, 3 cm above the anastomosis, thus

creating a “neo angle of His.” This was intended to reduce tension from the staple line and reduce the likelihood of bile reflux. The anastomosis was tested for leakage with blue dye. The choice of biliopancreatic limb length was tailored to the patient’s BMI with 150 cm used for BMI ≤ 50 kg/m² and 200 cm for super-obese patients (BMI > 50 kg/m²). When found, hiatal hernias were repaired with anterior, nonabsorbable suture closure over a 34F bougie.

Primary Operation Reversal In case of previous laparoscopic adjustable bands (LAGB), the band was freed from the surrounding fibrous capsule and adhesions, cut and extracted through one of the laparoscopic port sites. The internal fibrotic tissue between the band and the stomach was removed as well and the procedure continued as above. In cases of previous vertical banded gastroplasty (VBG), the synthetic band was located and removed. A narrow gastric pouch was fashioned proximal to this site and medial to the previous vertical stapler line. In cases of previous laparoscopic sleeve gastrectomy (LSG), the sleeve was transected at the incisura angularis and trimmed as necessary to create a narrow pouch. The gastrojejunostomy was continued as above.

Statistical Analysis Analysis of data was performed using SPSS 20.0 statistical analysis software (IBM Inc., Chicago, IL, USA). Continuous variables were compared using Student’s *t* test for independent samples. Categorical variables were described using frequency distributions and are presented as frequency (%). Categorical variables were compared using the chi-square or Fisher’s exact test as necessary. All tests are two-tailed and considered significant at $P < 0.05$.

The study was approved by the institutional review board.

Results

During the study period, 48 cSAGB and 106 pSAGB operations were performed. The study population characteristics are presented in Table 1. cSAGB and pSAGB did not differ in terms of gender, age, preoperative weight, and preoperative body mass index (BMI). Though not statistically significant, there was a male preponderance in the cSAGB group compared to the pSAGB group (45.5 vs. 35.9 %).

The most common indication for secondary operations was insufficient weight loss or weight regain, present in 94 %. The maximal average percent excess weight loss (%EWL) of these patients was 71.2 % after the primary operation, but decreased to 3.0 % before the conversional surgery. Less common indications were gastroesophageal reflux (GERD) and dysphagia following restrictive procedures (LSG, LAGB, and VBG). Of note, nine of the patients with insufficient weight loss had dysphagia and reflux as associated complaints, leading to LAGB deflation or removal. The most common primary

Table 1 Study population including both primary and conversional SAGB procedures

		Conversion to SAGB group (cSAGB)		Primary SAGB group (pSAGB)		P value	
		Mean	Range/percentage	Mean	Range/percentage		
Demographics	Group size (N=)	48		106			
	Male to female ratio	15:33		28:78		0.56	
	Age (years)	47.06	19–70	46.16	19–76	0.68	
Physical dimensions	Preoperative mean weight (kg)	117.06	74.4–177.0	118.6	84–214	0.72	
	Preoperative mean BMI (kg/m ²)	41.76	27.66–60.65	42.97	34.42–89.1	0.31	
Primary operations converted to SAGB	Primary operation type:						
	LAGB	31	64.6 %				
	LSG	15	31.3 %				
	VBG	2	4.2 %				
	Time interval between primary and cSAGB (years)	8.93	2–22				
Previous change to bariatric apparatus	Reversals without conversions to other bariatric procedures	LAGB removal	11(23 ^a)				
		VBG removal	1				
		Time interval between previous and conversion to SAGB (years)	5.25	0–14			
	Bariatric revisions/conversions	LSG revisions	1				
		Conversion of LAGB to LSG	2				
	Time interval between previous secondary procedure and current conversion to SAGB (years)	2	1–3				

SAGB single anastomosis gastric bypass, LAGB laparoscopic adjustable gastric band, LSG laparoscopic sleeve gastrectomy, VBG vertical banded gastroplasty, BMI body mass index

^a In addition to removed LAGBs, 12 other LAGBs remained in situ but leaked or were deflated by caregivers

procedure to be converted in the study was LAGB (65 %), followed by LSG (31 %) and VBG (4 %). Thirteen (42 %) of the LAGBs were removed prior to the current cSAGB, 4.69 years in average before the current cSAGB (range 0–14 years, SD 4.97). Two of these patients were converted to LSG and then to cSAGB, while 11 patients remained without a bariatric conversion until the current cSAGB (see Table 1).

The mean preoperative BMI and weight were 41.8 kg/m² and 117.2 kg, respectively, in the cSAGB group. These did not differ significantly from pSAGB. Table 2 presents the study group comorbidities prior to the operation. Of the recorded obesity-associated comorbidities, there were significantly more dyslipidemic patients in the pSAGB group. The cSAGB group had significantly more patients with GERD.

Operative times were significantly longer for cSAGB (157 ± 49 vs. 105 ± 45 min for pSAGB; *P* = 0.005). Average estimated blood loss was negligible (<50 ml) in both groups. Two patients from the 48 cSAGB group experienced postoperative complications. One patient developed a bleeding marginal ulcer at the gastrojejunal anastomosis, 2 months postoperatively. His primary operation was LSG, performed 2 years before conversion due to weight regain. He presented with symptomatic anemia (hemoglobin levels of 3 g/dL), treated with 6 units of packed red blood cells and taken for

urgent endoscopy. This revealed a marginal ulcer without active bleeding or need for intervention. The patient was discharged with proton-pump inhibitor (PPI) and is doing well on follow-up. A second patient suffered from myocardial infarction on the second postoperative day, treated with primary percutaneous cardiac intervention. In the pSAGB group, six patients had perioperative complications. These included one patient with anastomotic leak and septic shock, who underwent an urgent laparoscopic conversion to RYGB 4 days

Table 2 Preoperative comorbidities

Comorbidity	Prevalence in the study		P value
	cSAGB (total <i>n</i> = 48)	pSAGB (total <i>n</i> = 106)	
Diabetes mellitus	15 31.3 %	41 38.7 %	0.47
Dyslipidemia	19 39.6 %	65 61.3 %	0.015
Hypertension	12 25.0 %	40 37.7 %	0.143
Obstructive sleep apnea	2 4.2 %	17 16.0 %	0.06
Asthma	3 6.3 %	5 4.7 %	0.71
Gastroesophageal reflux	20 41.7 %	25 23.6 %	0.034

pSAGB primary single anastomosis gastric bypass, cSAGB conversional single anastomosis gastric bypass

after cSAGB. Following the conversion, due to another leak originating from the jejunojejunal anastomosis, the patient was taken again to the operating room with an attempted closure of the leak. As the repair failed, the patient was treated with a laparotomy and diversion. Two patients developed anastomotic stenosis and dysphagia, diagnosed by fluoroscopy and necessitated conversion to RYGB. Two patients developed a bleeding marginal ulcer, one treated by PPI alone and the other by endoscopic hemostasis. One patient developed mild intra-abdominal bleeding demonstrated by bloody discharge in his drain and a reduction in hemoglobin, but did not require any intervention (Table 3). Length of hospital stay was similar between the two groups (2.8 vs. 2.6 days for the pSAGB and cSAGB, respectively; $P = 0.8$).

For the entire cohort, follow-up data at 1, 3, and 6 months postoperatively was available for $n = 148$ (98 %), $n = 90$ (82 %), and $n = 34$ (79 %), respectively. The cSAGB subgroup had data available for $n = 47$ (100 %), $n = 32$ (92 %), and $n = 11$ (79 %), respectively. Weight loss outcomes were analyzed and compared between cSAGB and pSAGB. There was significantly greater percent total body weight loss for pSAGB compared to cSAGB for 1, 3, and 6 months postoperatively. This amounted to 9.6 vs. 7.9 %, 19.0 vs. 15.4 %, and 28.7 vs. 21.8 %, respectively (all $P < 0.01$). Mean percent excess weight loss (%EWL) at 3 and 6 months postoperatively demonstrated the same trend with 48.0 vs. 38.6 % and 74.8 vs. 51.0 %, respectively (both $P < 0.01$, Fig. 1). The difference was not significant for the first postoperative month (24.1 vs. 21.6 %, $P = 0.13$). BMI loss was significantly greater for pSAGB in the first and third postoperative months (4.1 vs. 3.4 kg/m² and 8.2 vs. 6.8 kg/m², both $P < 0.05$) (Fig. 2). However, the difference for the sixth month did not reach statistical significance, probably due to the small sample size (12.1 vs. 10.0 kg/m², $P = 0.12$). Figure 3 depicts the mean excess weight loss pattern for the cSAGB group, from the

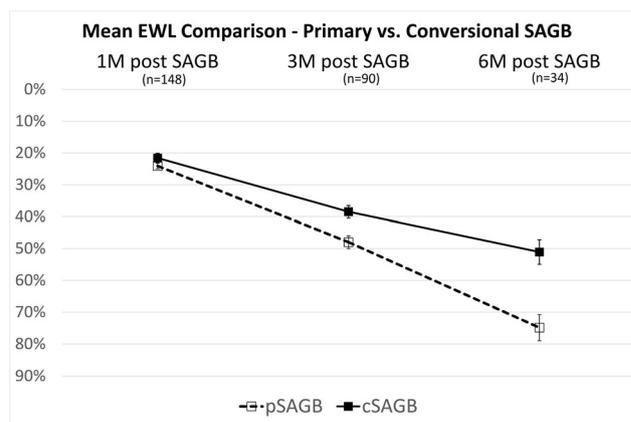


Fig. 1 Mean EWL comparison—primary vs. conversional SAGB. EWL excess weight loss, pSAGB primary single anastomosis gastric bypass, cSAGB conversional single anastomosis gastric bypass

primary operation through the conversional surgery and postoperative checkpoints for the latter.

Discussion

The current study retrospectively compared conversional to primary SAGB. A decreased efficacy for weight reduction in conversional procedures was found, for the initial postoperative period. This relative deficit was significantly demonstrated for the first 3 and 6 months postoperatively for EWL, and for the first month and 3 months for BMI loss. So far, better weight loss outcomes have been observed for primary relative to secondary RYGB [16, 17], but this has been inconsistent [7, 18]. SAGB studies have so far shown comparable outcomes between primary and secondary procedures [12, 14, 19]. The current study's findings highlight the different initial weight loss achieved in secondary compared to primary SAGB,

Table 3 Complications of primary and conversional SAGB

Complication type	Prevalence in the study		Treatment
	cSAGB (total $n = 48$)	pSAGB (total $n = 106$)	
Leak		1	Conversion to Roux-en-Y gastric bypass
Intragastric bleeding—perioperative		1	Endoscopic hemostatic clip placement
Intragastric bleeding—late (due to marginal ulcer)	1	1	Blood transfusion and PPI medication
Intra-abdominal bleeding		1	Blood transfusion
Obstruction of gastrojejunal anastomosis		2	Conversion to Roux-en-Y gastric bypass
Acute myocardial infarction	1		Percutaneous coronary arteriography with stent placement
Total morbidity	2 (4.2 %)	6 (5.6 %)	

pSAGB primary single anastomosis gastric bypass, cSAGB conversional single anastomosis gastric bypass, PPI proton pump inhibitors

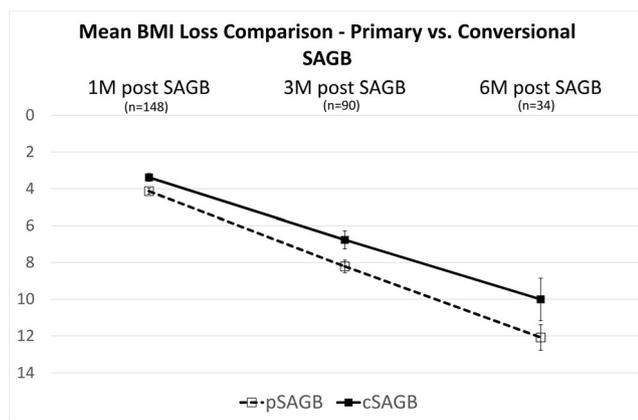


Fig. 2 Mean BMI loss comparison—primary vs. conversional SAGB. BMI body mass index, pSAGB primary single anastomosis gastric bypass, cSAGB conversional single anastomosis gastric bypass

which is apparent in percent total weight loss, percent EWL, and absolute BMI loss up to 6 months postoperatively. At the study’s longest term follow-up checkpoint (6 months), 87 % of pSAGB patients achieved success (EWL >50 %), whereas only 55 % attained success in the cSAGB group. The cSAGB success ratio did not change when EWL was considered relative to the baseline weight, as measured before the primary operation.

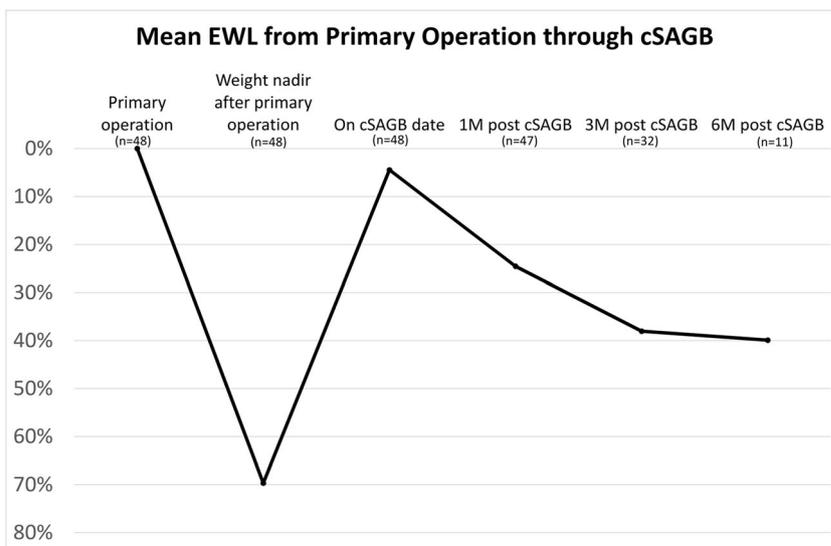
Defining the underlying cause for the difference in outcomes is difficult, but an important distinction must be made between causes pertaining to the *patient population* in need for a reversal, or to the *surgical challenge* presenting in secondary operations. In the former case, one may hypothesize that the population that undergoes secondary operations—most commonly for insufficient weight loss—may be “resistant” to bariatric operations, or perhaps simply noncompliant. While an intriguing direction to explore, the current study’s results do not suggest this is decisive; in patients who underwent cSAGB for insufficient weight loss, maximal EWL after the

primary operation did not correlate with EWL following their SAGB conversion (Pearson correlation coefficient of 0.097). This does not take into account; however, the difference between cSAGB’s malabsorptive component and the fact that the primary operations previously performed in the cSAGB group were purely restrictive. The possibility of intraoperative technical challenge, relative to primary operations, remains conceivable as a cause for the observed difference in weight loss outcomes. Furthermore, the state of the proximal stomach following the primary operation may potentially influence the outcomes. Eleven of the 48 patients in the cSAGB had long-term GERD and/or dysphagia after the primary operation, suggesting this is an important factor to consider in research of conversional surgery. Unfortunately, our study was underpowered to detect this factor’s influence on outcomes.

The greater male preponderance in the cSAGB group, though not statistically significant, may have modulated weight loss outcomes, further complicating the intergroup comparison. Some studies suggest that weight loss outcomes depend on gender [20]. Operative time was significantly longer for the conversional group. This is rather intuitive as a previous bariatric procedure may induce adhesions and deformation or the anatomy, accounting for the longer operative times. It should also be noted that the cSAGB included patients in which a previously placed band was removed simultaneously, accounting for longer surgeries. The length of surgery did not, however, influence postoperative morbidity or length of hospital stay.

Complications during the follow-up period were infrequent in both study groups, precluding any comparison between them. The only complication that appeared in both groups was bleeding marginal ulcer, in one patient in each group (2 and 0.94 % for cSAGB and pSAGB, respectively). While we are not aware of previous reports of this complication in secondary SAGB, it is comparable to the rate reported for

Fig. 3 Mean EWL from primary operation through cSAGB. EWL excess weight loss, cSAGB conversional single anastomosis gastric bypass



primary SAGB [19]. There were notably no leaks in the cSAGB group, whereas one patient in the pSAGB incurred a leak, constituting a 0.94 % leak rate. This result compares favorably with the previously reported leak rate of 2–3 % in cSAGB, 1.2 % in pSAGB [10, 15, 21], and 1–2 % of RYGB [22, 23]. All in all, the current study presents an acceptable safety profile for cSAGB, which is comparable to that already reported for these settings. However, the study was underpowered for statistical comparison of complications between primary and secondary operations.

In many bariatric units, RYGB is considered the secondary procedure of choice [24]. This preference is based on evidence for its effectiveness both as a primary and as a secondary operation, most commonly performed after restrictive operations such as LAGB [1, 25–27]. In this context, RYGB is considered to have a double advantage: First, it adds a malabsorptive component to a purely restrictive operation (albeit with a favorable hormonal component in both) [2, 25]; Second, it shifts the gastrointestinal anatomy to a low-pressure system, which is less prone to leakage [2, 24, 28]. Even so, secondary operations still suffer from higher complication rates when compared to primary procedures. These include leaks, internal fistulas, infections, and others [1, 2, 6, 7, 24, 29], with a mortality rate of up to 2 % [30]. Although RYGB has been considered as a keystone for secondary operations, there is clearly room for improvement.

Though not as effective as pSAGB, the current study's findings support the short-term effectiveness of cSAGB, with mean EWL of 51 % after 6 months. This highlights that while SAGB may be an acceptable secondary operation, the weight loss potential is still not as good as that of its primary counterpart. This necessitates, at the very least, preoperative clinical expectation matching between the surgeon and the patient; it furthermore prompts the (often difficult) question of choosing between secondary operation types.

Preoperative comorbidities detected for both studied groups differed significantly for dyslipidemia and GERD, with obstructive sleep apnea reaching borderline significance ($P = 0.06$). The most plausible explanation for GERD's overrepresentation in the cSAGB group (42 vs. 24 %, $P = 0.034$) is the gastric restriction imposed in the primary operations. The reasons for dyslipidemia and obstructive sleep apnea overrepresentation in the pSAGB group remain to be elucidated.

The study's results were obtained from 154 consecutive SAGB procedures conducted by a high-volume multidisciplinary bariatric center. Statistical loss to follow-up was 2 % in the first postoperative month, with approximately 20 % for later checkpoints. However, percent total body weight loss and percent EWL difference have retained their statistical significance in the 3 and 6 months' checkpoints.

GERD following SAGB is uncommon, ranging from 0 to 5 % [15, 31, 32]. As the pouch of SAGB is similar to a sleeve, there are concerns regarding worsening or even de novo

GERD. Until better data is available, it might be prudent to avoid SAGB in patients with GERD and perform standard Roux-en-Y gastric bypass. This information was conveyed to all patients but they were allowed to choose SAGB.

This study has some limitations. First, it reports on a relatively short follow-up time: 6 months after the operation, making the observations herein presented—initial outcomes only. Longer-term follow-up may change some of the difference observed between cSAGB and pSAGB. Second, the by low rate of complications preclude statistical comparison between primary and secondary procedures. Third, data did not include lifestyle and dietary habits. Secondary maladaptive eating habits which are sometimes present following (failed) bariatric procedures may hamper the effectiveness of bariatric surgery. Future studies are needed to explore the metabolic benefits of cSAGB (i.e., amelioration of diabetes mellitus), rather than weight loss alone.

Conclusion

The current study explored the initial outcomes of cSAGB in comparison to pSAGB. Six months postoperatively, mean EWL was an encouraging 51 % for the conversional procedure, but this was inferior to the primary counterpart's rate of 74.8 %. As seen in other types of secondary bariatric procedures, cSAGB is inferior to pSAGB. However, the study demonstrated acceptable safety for conversional SAGB, making it a viable option in this context.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Statement This is a retrospective type of study; thus, formal consent is not required.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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