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SURGERY FOR OBESITY AND RELATED DISEASES

Review article

The role of total alimentary limb length in Roux-en-Y gastric bypass: a systematic review

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Abstract

Background: Roux-en-Y gastric bypass (RYGB) is an established surgical treatment for obesity. Variations in limb length during RYGB procedures have been investigated for optimizing weight loss while minimizing nutritional deficiencies. The role of the total alimentary limb length (TALL; Roux limb plus common channel [CC]), however, is poorly defined.
Objective: Compare TALL in RYGB procedures for weight loss outcomes and malnutrition.
Setting: Systematic review.
Methods: Ovid Medline and PubMed databases were searched for entries between 1993 and 2020. Search terms included "gastric bypass" and "TALL." Two independent reviewers screened the results.
Results: A total of 21 studies measured TALL in RYGB. Of these, 4 of 6 reported a relationship between TALL and weight loss. Additionally, 11 studies reported that when TALL was ≤400 cm and CC <200 cm, 3.4% to 63.6% of patients required limb lengthening for protein malnutrition.
Conclusions: The majority of studies on RYGB do not report TALL length. There is some evidence that weight loss is affected by shortening TALL, while a TALL ≤400 cm with CC<200 should be avoided due to severe protein malnutrition. More studies on the effect of TALL are needed. (Surg Obes Relat Dis 2022;18:555–563.) © 2021 American Society for Bariatric Surgery. Published by Elsevier Inc. All rights reserved.

Key Words: Total alimentary limb length; Roux-en-Y gastric bypass

Roux-en-Y gastric bypass surgery (RYGB) is established as an effective weight loss and co-morbidity resolution strategy that is superior to medical management alone [1,2]. Up to 20% of patients with morbid obesity (body mass index [BMI] >40 kg/m^2) and up to 40% of patients with super obesity (BMI >50 kg/m^2), however, will experience significant weight regain at 10-year follow-up [3–6]. Subsequently, studies have investigated the effect of changing limb lengths to optimize weight loss while minimizing nutritional deficiencies. Few studies, however, have focused on the impact of the total alimentary limb length (TALL), which is composed of the Roux limb (RL) and the common channel (CC). Of further note, the biliopancreatic limb (BPL) and TALL are closely related as increases in the BPL results in a shorter TALL [7,8].

Most surgeons do not measure TALL when performing RYGB with the exception of performing a distal RYGB.

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The primary aim of this study is to assess the impact of TALL on weight loss and nutritional status through a systematic review of the available literature in which the TALL in RYGB is reported.

Methods

Information sources and searches

A librarian searched the Ovid and MEDLINE databases and any additional studies identified using PubMed were added.

Eligibility criteria

All studies on RYGB published between 1993 and 2020 in the English language were included. Reports were searched for "total alimentary limb length" and "gastric bypass," and only studies that included both terms were further examined.

Study selection

Using reports identified by the librarian, 2 reviewers independently screened abstracts and full texts for relevance, and a consensus among authors was made for excluded articles. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagrams were employed for the process of article selection. Data at 1-year or follow-up duration with >70% participation were used for comparison.

Quality assessment

Study quality was assessed using the Quality in Prognosis Studies (QUIPS) tool [9]. The QUIPS tool assesses the risk of bias in 6 domains: (1) study participation, (2) study attrition, (3) measurement of risk factors, (4) outcomes measures, (5) controlling for confounding variables, and (6) analysis and reporting. Criteria in each domain are evaluated as low, moderate, or high risk of bias.

Results

Literature search and quality assessment

The results of our literature search are summarized as a PRISMA flowchart in Figure 1. There were a total of 2710 studies that met our initial search criteria. After duplicates were removed, abstracts screened for clinical relevance, and confirmation of TALL measurement, 21 studies were included for review. QUIPS score was calculated for each study for its risk of bias (Table 1). Two studies had a low risk of bias across all 6 categories and 4 studies had 2 or fewer categories with a moderate risk of bias.

Effectiveness of TALL in RYGB Surgery

TALL and weight loss in RYGB

A summary of the study characteristics is described in Table 2. Within this group, 6 studies had at least 2 comparative cohorts to analyze the effect of TALL on weight loss in RYGB (Table 3). Gadiot et al. lengthened the RL from 150 to approximately 422 cm and compared this to a standard RL of 150 cm. Both groups had similar TALL of approximately 520 cm with no difference in weight loss and a higher complication rate in the long RL group [10].

Three studies found a shorter TALL resulted in greater weight loss. Shah et al. studied distal RYGB and varied BPL length. Increasing BPL from 60 to 200 cm, which shortened TALL from 560 to 420 cm, resulted in improved weight loss that persisted out to 10-year follow-up. There was no difference in weight loss between the 2 groups that had 420-cm TALLs, but shortening the CC resulted in more protein calorie malnutrition [11]. Kalfarentzos

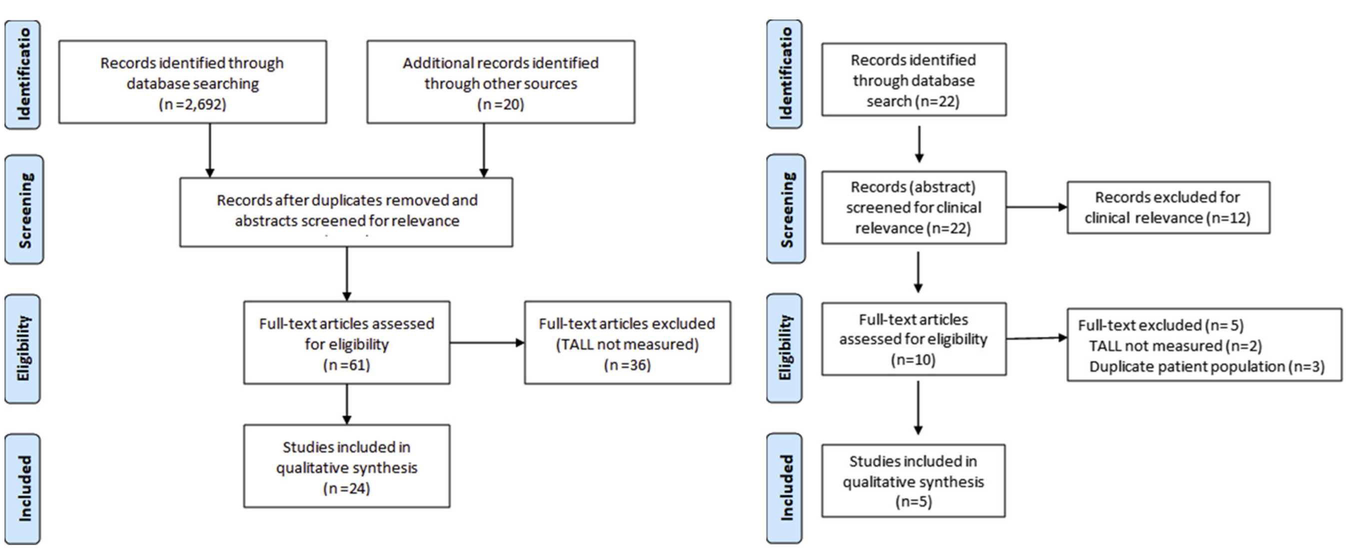

Figure 1. PRISMA flow diagram.

Table 1
Risk of bias/quality scores

Authors	Study participation	Study attrition	Prognostic factor measurement	Outcome measurement	Study confounding	Statistical analysis and reporting
Thurnheer et al. [25]	High	Low	Moderate	Low	High	Low
Savassi-Rocha et al. [41]	Moderate	NA	Low	Low	Moderate	Low
Schiavon et al. [28]	Moderate	NA	Low	Low	Moderate	High
Ahmed et al. [42]	Low	Low	Moderate	Low	Low	Low
Gadiot et al. [10]	Low	Low	Low	Low	Low	Low
Nelson et al. [24]	Moderate	Low	Moderate	Low	Moderate	Moderate
Navez et al. [43]	Low	Low	Low	Low	Low	Low
Chen et al. [27]	Low	Moderate	Moderate	Low	Moderate	Moderate
Shah et al. [26]	Low	Low	Low	Low	Moderate	Low
Skrikanth et al. [44]	Low	Low	High	Low	Moderate	Low
Van der burgh et al. [20]	Low	Moderate	Moderate	Low	Moderate	Low
Ghiassi et al. [22]	High	Moderate	Moderate	Low	Moderate	Low
Kalfarentzos et al. [12]	High	Moderate	Low	Low	High	High
Kaska et al. [14]	High	Low	High	Low	High	High
Kellum et al. [13]	High	Low	High	Low	High	High
Sugerman et al. [16]	High	Low	Moderate	Low	Moderate	Low
Scruggs et al. [15]	Moderate	NA	Moderate	Low	Moderate	Moderate
Shin et al. [21]	Low	Moderate	High	Low	Moderate	Low
Rawlins et al. [18]	High	Low	Moderate	Low	Moderate	Low
Kraljević et al. [19]	Moderate	Low	Moderate	Low	Moderate	Low
Fox et al. [17]	Moderate	High	Moderate	Low	Moderate	Low

NA = not applicable; these studies excluded patients that were lost to follow-up.
Low = low risk of bias; moderate = moderate risk of bias; high = high risk of bias.

et al. also found that lengthening BPL and subsequently shortening TALL resulted in better weight loss [12]. Kellum et al. compared RYGB with a long unmeasured BPL and 250-cm TALL to RYGB with 150-cm RL and 75-cm BPL and found significantly greater weight loss in the former but at the cost of significant protein malnutrition [13].

Two studies found no difference when TALL was shortened. Kaska et al. increased BPL by 50 to 75 cm and found no significant difference in weight loss [14]. Scruggs et al. compared long BPL distal RYGB with standard RYGB and found no difference in weight loss at 1 year; however, this study is limited by very small sample size (N = 16) [15].

Co-morbidity improvement

Overall, 3 studies compared co-morbidity improvement or resolution with changes in TALL (Table 3). In 2 studies, varying the RL length was not associated with a difference in co-morbidity resolution [10,12], whereas Kaska et al. studied the effect of BPL length and reported a longer BPL limb was associated with better diabetes type 2 reduction [13].

Malnutrition and TALL in RYGB

Within the 21 articles identified, 16 studies measured the TALL and CC and reported nutritional outcomes.

TALL ≤400 cm

In 1997, Sugerman et al. reported that a 50-cm CC and 300-cm TALL in RYGB was too short, with 100% of patients requiring revision surgery (Table 4) [16]. Subsequently, 6 studies investigated the effect of a 100- to 150-cm CC and ≤400-cm TALL. These studies report significant issues with hypoalbuminemia in 13.6% to 29.4% of patients, and 3.4% to 43.7% of patients required limb lengthening [12,13,17–20]. Shin et al. and Ghiassi et al. studied RYGB with <200-cm CC and <300-cm TALL and reported 13.6% and 63.6% of patients, respectively, required limb lengthening [21,22]. Srikanth et al. reported that with a 300-cm TALL, a >150-cm CC provided a better balance between weight loss and nutritional deficiencies [23].

Tall >400 cm

Three studies reported a 100-cm CC with a 400- to 700-cm TALL resulted in a lower limb lengthening rate (1.1%–3.5%) compared with studies using a 100-cm CC with TALL ≤400 cm (Table 4) [10,24,25]. Within these studies, however, Thurnheer et al. reported a hypoalbuminemia rate of 13.3% with a 100-cm CC and >600-cm TALL, although the limb lengthening rate was low at 1.1% [25]. Shah et al. studied RYGB patients with a 150-cm CC and 420-cm TALL and reported 9.1% of patients required parental or enteral feeding, a rate that decreased to 3.3% when the CC was >200 cm [26]. In a study only involving patients who required revision after RYGB, Chen et al. reported that when the CC is <400 cm with a TALL >500 cm, significant protein calorie malnutrition requiring revision occurred in 1.8% of patients [27]. Finally, Schiavon et al. studied 45 patients

Table 2
Studies measuring total alimentary limb length

Authors	Yr	Country	Study type	Procedure	Focus on superobese	Revision	Total pts, n	Study period	Follow-up period, yr	Follow-up yr*, n (%)	Method of bowel measurement
Thurnheer et al. [25]	2012	Switzerland	Retrospective study	Distal RYGB	No	No	355	2002–2010	5	1 (60)	NA
Savassi-Rocha et al. [41]	2008	Brazil	Prospective study	RYGB	Yes	No	100	2004–2005	1	1 (100)	Minimal tension, silk string
Schiavon et al. [28]	2018	Brazil	Substudy of RCT	RYGB	No	No	45	NA	1	1 (100)	Unstretched bowel, 10-cm instrument
Ahmed et al. [42]	2019	United States	Retrospective study	RYGB	No	No	1730	2006–2009	7	5 (86)	Variable techniques
Gadiot et al. [10]	2020	Netherlands	RCT	RYGB	No	No	196	2014–2018		1 (95.5)	Unstretched bowel, 5cm instrument
				RYGB			211				
Nelson et al. [24]	2006	United States	Retrospective study	RYGB	Yes	No	257	1985–2004	2	2 (73)	NA
								(range, 1–12)			
Navez et al. [43]	2016	Belgium	Prospective study	RYGB	No	No	90	NA	1	1 (100)	Unstretched bowel, silk string
Chen et al. [27]	2019	Taiwan	Retrospective study	OAGB	No	Yes	12	1998–2016	3	1 (74)	NA
				RYGB			7				
Shah et al. [26]	2019	Norway	Retrospective study	RYGB	Yes	No	69	2006–2015	10	5 (74)	Unstretched bowel, instrument
				Distal RYGB			88				
				Distal RYGB			30				
Skrikanth et al. [44]	2010	United States	Retrospective study	Distal RYGB	Yes	Yes	17	1993–2005	13	10 (83.3)	Minimal tension
				Distal RYGB			21				
Van der burgh et al. [20]	2020	Netherlands	Retrospective study	Distal RYGB	No	Yes	44	2014–2018	4	1 (95)	NA
Ghiassi et al. [22]	2018	United States	Retrospective study	Distal RYGB	No	Yes	11	2010–2016	3	1 (70)	NA
							85				
Kalfarentzos et al. [12]	2011	Greece	Retrospective study	Distal RYGB	Yes	No	75	1996–2001	8	2 (96)	Fully stretched bowel
				Distal RYGB			44			2 (82)	
				BPD			841			2 (66)	
Kaska et al. [14]	2014	Poland	Retrospective study	RYGB	No	No	51	2008–2010	2	2 (100)	Fully stretched bowel
				RYGB			42				
Kellum et al. [13]	2011	United States	Retrospective study	Distal RYGB	Yes	No	49	1985–1989	10 ± 6.1	5 (70.4)	NA
				RYGB			92				
Sugerman et al. [16]	1997	United States	Retrospective study	Distal RYGB	Yes	Yes	22	1986–1988	5	1 (92)	NA
				Distal RYGB			5				
Scruggs et al. [15]	1993	United States	Retrospective study	RYGB	No	No	8	1989–1991	1	1 (100)	NA
				Distal RYGB			8				
Shin et al. [21]	2018	United States	Retrospective study	Distal RYGB	No	Yes	22	2012–2017	2	1 (86)	NA
Rawlins et al. [18]	2011	United States	Retrospective study	Distal RYGB	No	yes	29	2002–2009	5	1 (100)	NA
Kraljević et al. [19]	2020	Switzerland	Retrospective study	Distal RYGB	No	Yes	28	2008–2015	6	3 (89)	NA
Fox et al. [17]	1996	United States	Retrospective study	Distal RYGB	No	Yes	80	1992–1994	4	1 (40)	NA

BPD = biliopancreatic diversion; NA = not specified; OAGB = one anastomosis gastric bypass; Pts = patients; RCT = randomized control trial; RYGB = Roux en Y gastric bypass.
* Follow-up years indicates the percentage follow-up at 1 year or the year where there was at least 70% follow-up.

Table 3
Effect of total alimentary limb length on weight loss and co-morbidity improvement

Authors	Total pts, n	BMI	TSBL, cm	BPL, cm	RL, cm	CC, cm	TALL, cm	Gastric pouch size, mL	Weight loss			T2D, n (%)	HTN, n (%)	HLD, n (%)
									EWL, %	TWL, %	Change BMI			
Gadiot et al. [10]	196	42.7 ± 4.5	587 (390–890)	60	422 (210–730)	100	522	—	84.3	34.2	—	22 (68.8)	32 (46.4)	48 (58.8)
	211	42.3 ± 4.4	598 (355–985)	60	150	383 (145–755)	533	—	85.3	33.6	—	25 (53.2)	45 (57.7)	48 (55.8)
Shah et al. [26]	69	54.6 (50–81.1)	620 (420–870)	60	150	410 (estimated)	560	—	62.0*	36.0*	—	—	—	—
	88	58.5 (50.2–73.4)	—	200	270 (estimated)	150	420	—	71.0	40.0	—	—	—	—
	30	57.4 (50–68.3)	—	200	220 (estimated)	200	420	—	69.0	39.0	—	—	—	—
Kalfarentzos et al. [12]	75	56.2 ± 7.3	—	80	—	100	—	15 ± 5	55.8*	—	18.6*	15 (100)	33 (75.0)	29 (80.6%)
	44	51.7 ± 7.4	—	—	250	100	350	15 ± 5	77.3	—	22.5	12 (100)	15 (88.2)	21 (87.5)
	841	57.1 ± 9	—	—	400	100	500	40 ± 10	72.1	—	25.4	178 (97.8)	170 (80.9)	252 (91.6)
Kaska et al. [14]	51	43.3 ± 5.7	470.9 ± 108.23	68.8 ± 8.48	157.9 ± 50.11	237 ± 59.75	394	30–40	—	—	2 ± 5.4	38 (74.5) Hb <6	—	—
	42	45.1 ± 5.5		133.2 ± 17.50	151.4 ± 27.97	193.5 ± 56.72	344	—	—	—	17.3 ± 4.2	40 (95.2) Hb <6*	—	—
Kellum et al. [13]	49	57.9 ± 8.3	—	—	100–200	50–150	250	50	72.4* ± 15.0	—	25.1*	—	—	—
	92	58.6 ± 9.6	—	75	150	—	—	—	55.1 ± 24.7	—	20.3	—	—	—
Scruggs et al. [15]	8	42.7 ± 9	—	60	90	—	—	30	—	46.9	—	—	—	—
	8	51.4 ± 9	—	—	90	180–240	270–310		—	56.9	—	—	—	—

pts = patients; BMI = body mass index; TSBL = total small bowel length; BPL = biliopancreatic limb; RL = Roux limb; CC = common channel; TALL = total alimentary limb length; EWL = excess weight loss; TWL = total weight loss; T2D = type 2 diabetes; HTN = hypertension; HLD = hyperlipidemia.

Co-morbidities are listed as number and present improvement or resolution.

* $P < .05$ when compared against the other cohort.

Table 4
Effect of total alimentary limb length and common channel on malnutrition

Authors	Pts, n	BPL, cm	RL, cm	CC, cm	TALL, cm	LL, n (%)	HypoAlb, n (%)	Supp feed, n (%)	Vit B1, n (%)	Vit B12, n (%)	Ca, n (%)	PTH, n (%)	Vit D, n (%)	Iron, n (%)	Mortality,* n (%)
Thurnheer et al. [25]	355	78 ± 14.1	604 ± 99	76.1 ± 7.2	680.1	4 (1.1)	47 (13.3)	—	—	35 (16.6)	1 (0.4)	30 (14.1)	15 (7.2)	—	0 (0)
Schiavon et al. [28]	45	100	150	466.3 ± 86.4	616.3	—	—	—	—	29.60 ± 22.87†	—	—	—	18.14 ± 40.16†	—
Gadiot et al. [10]	196	60	422 (210–730)	100	522	3 (1.5)	—	0 (0)	—	—	—	—	—	—	0 (0)
	211	60	150	383 (145–755)	533	—	—	0 (0)	—	—	—	—	—	—	0 (0)
Nelson et al. [24]	257	50	300–500	100	400–600	9 (3.5)	—	—	—	—	—	—	—	—	2 (.8)
Chen et al. [27]	12 (OAGB)	222 ± 104.3	251 ± 71.7	294 ± 71.3	609.5 ± 48.1	19 (100)	19 (100)	—	—	—	—	—	—	—	0 (0)
	7							—	—	—	—	—	—	—	0 (0)
Shah et al. [26]	69	60	150	410 (estimated)	560	—	0 (0)	1 (1.4)	—	—	—	—	—	—	0 (0)
	88	200	270 (estimated)	150	420	—	1 (1.1)	8 (9.1)	—	—	—	—	6 (6.8)	2 (2.3)	0 (0)
	30	200	220 (estimated)	200	420	—	2 (6.7)	1 (3.3)	—	—	—	—	—	—	0 (0)
Srikanth et al. [23]	17	—	150	<150	250–300	0	—	1 (5.8)	—	—	—	—	2 (11.8)‡	—	0 (0)
	21	—	—	>150	300	0	—	1 (4.7)	—	—	—	—	3 (14.3)‡	—	0 (0)
Van der burgh et al. [20]	44	—	300	100	400	8 (18.2)	6 (13.6)	—	0 (0)	11 (26)	26 (60)	—	—	—	1 (2.3)
Ghiassi et al. [22]	11	—	100	150–200	250–300	7 (63.6)	3 (27.3)	3 (27.3)	—	—	—	—	—	—	0 (0)
	85	200–700	100	300–350	400–450	—	4 (14.3)	—	1 (5.6)	1 (5)	2 (7.4)	8 (40)	14 (66.7)	5 (21.7)	0 (0)
Kalfarentzos et al. [12]	75	80	—	100	—	1 (1.3)	2 (2.7)	1 (1.3)	—	14 (19.4)	1 (1.4)	3 (4.2)	—	12 (16.7)	2 (2.7)
	44	—	250	100	350	6 (13.6)	11 (25.0)	5 (11.0)	—	10 (25)	2 (5.5)	3 (8.3)	—	12 (30.6)	0 (0)
	841	—	400	100	500	8 (.95)	26 (3.1)	18 (2.1)	—	175 (23.4)	7 (.9)	36 (4.8)	—	101 (13.5)	4 (.5)
Kellum et al. [13]	49	—	100–200	50–150	250	21 (43.7)	—	7 (14.6)	—	436.0 ± 321§	8.0 ± .7§	—	11.4 ± 9.6§	24.4 ± 15.5§	1 (2)
	92	75	150	—	—	—	—	—	—	521.9 ± 440§	8.9 ± .5§	—	16.6 ± 13.9§	53.7 ± 28.8§	—
Sugerman et al. [16]	22	—	145	150	295	3 (13.6)	3 (13.6)	4 (18.2)	—	—	5 (23)	—	13 (63)	—	—
	5	—	250	50	300	5 (100)	5 (100)	5 (100)	—	—	—	—	—	—	2 (40)
Shin et al. [21]	22	—	107.4 ± 34.8	155.5 ± 33	255.8	3 (13.6)	5 (29.4)	—	2 (11.8)	4 (22.2)	—	9 (50)	—	1/17 (5.9)	0 (0)
Rawlins et al. [18]s	29	—	150	100	250	1 (3.4)	9 (31.0)	6 (20.7)	—	9 (32)	—	8 (27)	23 (82)	10 (36)	0 (0)
Kraljević et al. [19]	28	50	150	100	250	6 (21.4)	8 (28.6)	—	—	14 (50)	4 (14)	—	17 (60)	—	0 (0)
Fox et al. [17]	80	—	150	100	250	—	21 (26.3)	3 (3.8)	—	5 (6)	11 (14)	—	20 (25)	26 (33)	1 (1.3)

Pts = patients; BPL = biliopancreatic limb; RL = Roux limb; CC = common channel; TALL = total alimentary limb length; LL = reoperation for limb lengthening; HypoAlb = hypoalbuminemia; Supp feed = requiring enteral or parenteral nutrition; Vit = vitamin; Ca = calcium; PTH = parathyroid hormone.

Unless otherwise specified, values are listed as number of patients (% of total) that have low levels of respective vitamins.

* Surgically related mortality.

† Mean percentage reduction.

‡ Combination of Ca and vit D.

§ Mean lowest level.

with 100-cm BPL and 150-cm RL and reported an average CC length of 466.3 ± 86.4 cm resulted in minimal nutritional deficiencies [28].

Discussion

Determining the optimum limb length for RYGB procedures requires maintaining a balance between optimizing weight loss while avoiding malnutrition. This review aims to assess the effect of TALL in RYGB. In considering the data available, it is important to reiterate that if the BPL is kept constant and the RL or the CC length is variable, the net result is that the patient will have the same TALL. Conversely, if the RL is kept constant and the BPL or the CC is lengthened, then the patient will have a variable length of the TALL. The majority of published studies on RYGB do not measure TALL. Using the available literature in which TALL is reported, decreasing TALL (by increasing the BPL) appears to be a more important factor for weight loss than increasing the RL length. Additionally, to prevent significant rates of protein malnutrition, a ≤400-cm TALL with a <200-cm CC should be avoided.

The importance of TALL on weight loss has been supported by other studies that have investigated varying the length of the BPL, which also varies the TALL. Nergaard et al. and Homan et al. randomized patients to a long BPL or a short BPL and found patients experienced better weight loss in the former [29,30]. Zorilla-Nunez et al. published a systematic review on the effect of the BPL and found that a longer BPL likely has improved metabolic benefits [31]. Conversely, changing the length of the RL while keeping the BPL constant does not affect the overall TALL. Several studies have also demonstrated that increasing RL does not affect weight loss, particularly in those with BMI <50 kg/m^2 [32,33]. This evidence is supported in a review by Stefanidis et al. who reported that a longer RL may benefit the super obese, but is unlikely to impact patients with BMI <50 kg/m^2 [34].

Within the literature identified, there were 2 studies that did not report a relationship between the TALL and weight loss. In the first of these reports, the study by Kaska et al. varied the TALL by an average of 50 cm, raising the possibility that such an adjustment may not be long enough to significantly impact weight loss [14]. In the second study, there were 8 patients in the control and treatment arms, thus limiting potential data interpretation due to the relatively small sample size [15].

When considering the impact of TALL on weight loss, it is equally important to emphasize its potential impact on nutritional deficiencies. From the existing literature available on RYGB, if the TALL is ≤400 cm and the CC length is <200 cm, significant protein malnutrition and a high revision rate occurred. When TALL is closer to 500 to 600 cm, however, a CC <200 cm appears to be better tolerated with a lower rate of protein malnutrition requiring limb lengthening. One explanation for this finding may be the postoperative physiological adaptation of the RL. Previous studies have identified changes in cell proliferation, intestinal glucose transporters, and villous height in the RL after RYGB [35–37]. Thus, while we are unable at this time to determine the optimum TALL and CC length for weight loss in RYGB procedures, it is evident that a combination of a TALL ≤400 cm and a CC<200 cm results in a significant proportion of protein malnutrition and should be avoided.

In considering the effect of TALL in RYGB, it is also important to understand the effect of gastric pouch size. RYGB, biliopancreatic diversion, and biliopancreatic diversion with duodenal switch (BPD/DS) all share a similar Roux-en-Y configuration but with significant variations in pouch size and presence or absence of a pylorus. A TALL of 250 to 300 cm and CC of 100 cm following BPD/DS results in a much lower rate of revision for protein malnutrition than a RYGB with similar limb lengths [38–40]. While this may be due to the larger gastric pouch size and a preserved pylorus in the BPD/DS, further studies are required to confirm this association.

There are limitations of this review. By the nature of all systematic reviews, there is an inherent limitation created by the quality of the available data. The majority of studies included in this systematic review were retrospective cohort studies, many of which are limited by relatively small sample sizes. There is also heterogeneity in these studies with inclusion of both primary and revisional surgeries, a variety of different limb lengths, and a variety of different limb length measurement techniques. Lastly, the majority of studies did not have follow-up longer than 2 years, and thus the relationship of limb lengths and long-term malnutrition is not known. More randomized controlled trials on the effect of TALL in RYGB is required.

Conclusions

The TALL may be the closely related to weight loss; however, a TALL ≤400 cm with a CC <200 cm should be avoided due to increased risk of significant protein malnutrition. To date, studies that specifically report TALL following RYGB procedures remain limited, and more studies are required.

Disclosures

K.S.G.: GI Dynamics, consultant; W.L.G.: speaker; Standard Bariatrics, ownership interest. A.N.: Medtronic, speaker; Intuitive, travel honorarium. All other authors have no commercial associations that might be a conflict of interest in relation to this article.

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Editorial comment

Comment on: the role of total alimentary limb length in Roux-en-Y gastric bypass – a systematic review

We read with interest the systematic review by Wang et al. [1], which adds some new elements to the debate about the risk of protein malnutrition in distal Roux-en-Y gastric bypass (RYGB).

Traditionally, RYGB is considered a combined restrictive and malabsorptive procedure, but the mechanisms through which RYGB achieves significant and sustained weight loss are not fully understood. In particular, the hormonal and metabolic effects of bypass, such as the impact on hunger and satiety, probably account for a significant proportion of the outcomes [2]. A lack of complete understanding of the physiology of RYGB, together with the significant heterogeneity of studies published on this topic, are responsible for a wide variability of behavior among surgeons.

Some surgeons have focused on the restrictive components of RYGB, for instance, pouch and gastrojejunostomy size, while others argue that bypassing a longer small bowel length (SBL) could be associated with more malabsorption and therefore superior weight loss (WL). Studies are concordant that the superior impact of biliopancreatic limb (BPL) length on WL is through the complete loss of absorptive capacity, in comparison to the Roux limb (RL), which may still absorb some macronutrients, carbohydrates, in particular.

Two more elements participate in increasing the complexity of this issue. First, SBL is extremely variable in humans, with a range of 300–900 cm in most individuals, but more extreme lengths of 160 cm and 1500 cm have been reported. A linear correlation between weight and SBL has been excluded in the studies available. In particular, Tacchino, in a multivariate linear regression analysis model that included sex, age, height, and weight, found that only height was significantly correlated with SBL [3]. The other important element is the lack of accuracy and reproducibility in SBL measurement, which must always be considered.

The vast majority of surgeons perform a proximal RYGB with fixed limb lengths without measuring the total SBL (TSBL). This is in accord with the review by Mahawar et al., which concluded that RYGB achieves optimum results with a combined length of BPL and RL of 100–200 cm whereas bypassing more SBL does not improve WL predictably and significantly, except maybe for patients with super obesity. Interestingly, the same authors recommend the measurement of TSBL when longer SBL is bypassed [4].

Distal RYGB is used by a minority of surgeons in 2 situations: patients with super obesity and WL failure (WLF, insufficient WL, or weight regain) after proximal RYGB.

The use of distal RYGB in patients with BMI $>$50 kg/m^2 is debatable because a superior WL in comparison to proximal RYGB can be achieved only at the price of adding malabsorption. This is in contrast with a basic principle in bariatric surgery that must always be kept in mind: in malabsorptive procedures restriction must be limited, increasing gastric pouch volume and/or preserving the pylorus. Moreover, in such patients, where performing an RYGB may already represent an extreme technical challenge, the surgeon is obliged to measure the TSBL, which may be time-consuming and cause bowel lesions. In patients with super obesity, several malabsorptive procedures have proven to be effective and should be preferred, such as biliopancreatic diversion with duodenal switch, single-anastomosis duodeno-ileal bypass with sleeve gastrectomy, and one anastomosis gastric bypass (OAGB). In a recent study, our results after OAGB with a 150-cm BPL were promising in terms of efficacy and WL outcomes [5]. In our experience, OAGB was technically more straightforward compared with RYGB in this category of patients.

The other possible indication for distal RYGB is the distalization of a proximal RYGB after WLF. Unfortunately, WLF is quite a common situation that represents a real