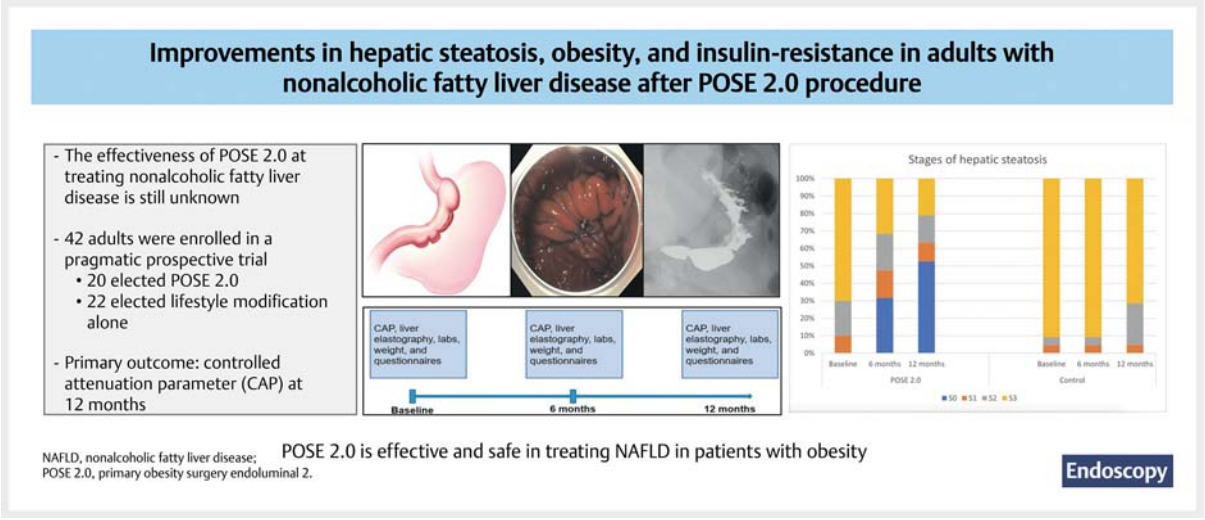
Accepted Manuscript online: 2023-06-26 Article published online: 2023-08-24

Improvements in hepatic steatosis, obesity, and insulin resistance in adults with nonalcoholic fatty liver disease after the primary obesity surgery endoluminal 2.0 procedure

GRAPHICAL ABSTRACT



Authors

Maryam AlKhatry[1], Babusai Rapaka[2], Daniel B. Maselli[2], Donna Maria Abboud[2], Vitor O. Brunaldi[2,3], Tala Mahmoud[2], Rabih Ghazi[2], Farah Abdul Razzak[2], Khushboo Gala[2], Imad Joudah[1], Fedaa Housen[1], Sana Al Qadi[1], Eric J. Vargas[2], Andrew C. Storm[2], Barham K. Abu Dayyeh[2]

Institutions

1 Department of Gastroenterology, Obaidulla Hospital, Ras Al Khaimah, Emirates Health Services, Ministry of Health, United Arab Emirates
2 Division of Gastroenterology and Hepatology, Mayo Clinic, Rochester, Minnesota, United States
3 Gastroenterology Department, University of Sao Paulo Medical School, Sao Paulo, Brazil

submitted 6.2.2023
accepted after revision 26.6.2023
accepted manuscript online 26.6.2023
published online 24.8.2023

Bibliography
Endoscopy 2023; 55: 1028–1034
DOI 10.1055/a-2117-6274
ISSN 0013-726X

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

Tables 1 s–6 s
Supplementary material is available under https://doi.org/10.1055/a-2117-6274

Scan this QR-Code for the author commentary.

Corresponding author
Barham K. Abu Dayyeh, MD, MPH, Division of Gastroenterology and Hepatology, Mayo Clinic, 200 First Street Southwest, Rochester, MN 55905, United States
Abudayyeh.barham@mayo.edu

ABSTRACT

Background The primary obesity surgery endoluminal 2.0 (POSE 2.0) procedure involves full-thickness gastric body plications to narrow the stomach using durable suture anchor pairs. We evaluated POSE 2.0 as a treatment strategy

for nonalcoholic fatty liver disease (NAFLD) in patients with obesity.

Methods Adults with obesity and NAFLD were prospectively allocated based on their preference to undergo POSE 2.0 with lifestyle modification or lifestyle modification alone (control). Primary end points were improvement in controlled attenuation parameter (CAP) and resolution of hepatic steatosis at 12 months. Secondary end points included %total body weight loss (%TBWL), change in serum measures of hepatic steatosis and insulin resistance, and procedure safety.

Results 42 adult patients were included (20 in the POSE 2.0 arm and 22 in the control arm). At 12 months, POSE 2.0 significantly improved CAP, whereas lifestyle modification alone did not ($P<0.001$ for POSE 2.0; $P=0.24$ for control). Similarly, both resolution of steatosis and %TBWL were significantly higher with POSE 2.0 than with control at 12 months. Compared with controls, POSE 2.0 significantly improved liver enzymes, hepatic steatosis index, and aspartate aminotransferase to platelet ratio at 12 months. There were no serious adverse events.

Conclusion POSE 2.0 was effective for NAFLD in patients with obesity, with good durability and safety profile.

Introduction

Nonalcoholic fatty liver disease (NAFLD) continues to rise as a common cause of chronic liver disease globally [1]. The inflammatory subtype of NAFLD, nonalcoholic steatohepatitis (NASH), accelerates the development of end-stage liver disease and hepatocellular carcinoma, and is considered a harbinger of metabolic syndrome [2]. Weight loss is the only reliable treatment for NASH and histologic resolution of steatohepatitis, which usually happens when total body weight loss (TBWL) exceeds 10 % [3].

Endoscopic bariatric and metabolic therapies address management gaps in patients with obesity who have not responded to conservative medical interventions but are unfit for or decline surgical intervention. This presents a complementary therapeutic opportunity in NAFLD [4]. Endoscopic sleeve gastroplasty was shown to reduce insulin resistance and biochemical measures of steatosis in patients with NAFLD, providing rationale for further study of endoscopic bariatric and metabolic therapies in NAFLD [5, 6]. Primary obesity surgery endoluminal 2.0 (POSE 2.0) creates full-thickness plications of gastric tissue endoscopically to shorten the stomach and narrow its aperture, promoting significant weight loss [7].

Currently, there are no prospective published data on the efficacy and safety of POSE 2.0 in patients with NAFLD. Therefore, we conducted a pragmatic study of adults with obesity and NAFLD who elected to undergo POSE 2.0 with concomitant high-intensity lifestyle modification or lifestyle modification alone.

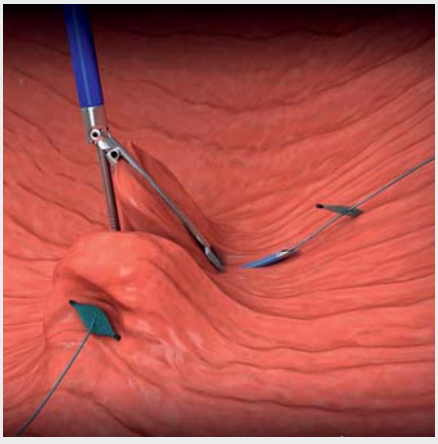
Methods

This prospective, open-label, clinical trial was approved by the United Arab Emirates (UAE), Ministry of Health and Prevention on January 16, 2020. The POSE 2.0 investigational arm was done under an investigational protocol approved by the local institutional review board and the Ministry of Health (#DD/CTMD2/019/2019). A licensed Contract Research Organization independently supervised and audited the study.

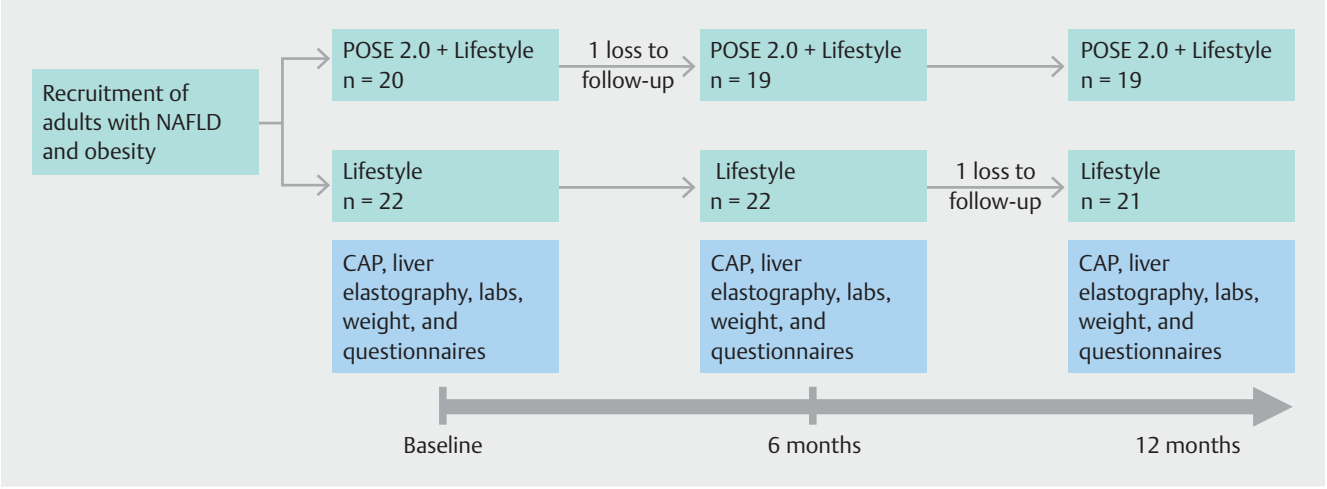
Patients were recruited from Obaidulla Hospital, Ras Al Khaimah, Emirates Health Services, Ministry of Health, UAE, from January 2020 to March 2021. Patients recruited into the study self-allocated to undergo the POSE 2.0 procedure with high-intensity lifestyle modification or lifestyle modification alone (control). This pragmatic design was adopted to reflect real-world clinical settings, enhance compliance and engagement, and reduce dropout rates that may arise from forced random allocation [8].

The POSE 2.0 procedure involves full-thickness plications by suture anchor pairs that shorten and tubularize the stomach along its greater curvature (▶ **Video 1**). The operator uses the Incisionless Operating Platform (USGI Medical, San Clemente, California, USA) [7, 9]. Both study arms underwent high-intensity lifestyle modification including caloric restriction and physical activity. Healthy living behavioral counseling and coaching was administered through weekly clinical visits in the first month followed by monthly visits for the remaining period of the study.

At baseline, and at 6 and 12 months, patients underwent evaluation for hepatic steatosis by FibroScan XL Probe (Echo-



Video 1 Animation of the primary obesity surgery endoluminal 2.0 (POSE 2.0) procedure.
Online content viewable at:
https://doi.org/10.1055/a-2117-6274



▶ **Fig. 1** Study schematic and flow chart. NAFLD, nonalcoholic fatty liver disease; CAP, controlled attenuation parameter.

sens, Paris, France) measuring controlled attenuation parameter (CAP) and liver stiffness by transient elastography. CAP is a noninvasive validated quantitative assessment of liver steatosis measured by the attenuation of ultrasonic waves introduced at a frequency of 3.5 MHz as they travel through the liver [10]. Patients also underwent complete hepatic biochemical testing and calculation of hepatic steatosis index (HSI), aspartate aminotransferase to platelet ratio (APRI), and fibrosis-4 scores.

Obesity-related measurements included body mass index (BMI) and %TBWL. Measures of insulin resistance and metabolic disease included glycated hemoglobin, fasting glucose, 2-hour postprandial glucose, serum insulin, homeostatic model assessment for insulin resistance, total cholesterol, low-density lipoprotein, triglycerides, and thyroid stimulating hormone. Patient-reported outcomes included the Three-Factor Eating Questionnaire 18 to evaluate change in eating habits and the Gastroparesis Cardinal Symptom Index questionnaire.

Primary outcomes were change in CAP and resolution of hepatic steatosis to S0 steatosis, without progression of fibrosis by ≥1 stage at 12 months. Secondary outcomes included improvements in biochemical measures of hepatic steatosis, obesity, insulin resistance, %TBWL, clinical response rates based on TBWL ≥5 %, ≥10 %, and ≥15 %, and changes in Three-Factor Eating Questionnaire 18 and Gastroparesis Cardinal Symptom Index scores, and device and procedure safety.

Continuous variables were presented as medians with interquartile ranges (IQRs) or means with 95 %CIs or SD, and categorical variables were presented as frequencies or percentages. All variables were tested for normality, and statistical tests were applied accordingly. Continuous variables were compared using Student's *t* test or the Wilcoxon signed-rank test, either for dependent or independent samples, as appropriate. Categorical variables were compared using Fisher's exact test. We employed the repeated-measures analysis of variance or the Kruskal–Wallis test for within-group comparisons of more than two means. If we found statistically significant differences, we ran post hoc analyses using the general linear model for adjusted pairwise comparisons. We employed IBM SPSS Statistics for Windows (IBM Corp., Armonk, New York, USA) and considered $P < 0.05$ as statistically significant.

Results

A total of 20 adults with median age of 30.5 years (IQR 26.5–38.2) and median BMI of 38.0 kg/m^2 (IQR 36.8–39.0) elected to undergo POSE 2.0, and 22 adults were included in the control arm and followed lifestyle modification alone (median age 41.0 years [IQR 30.0–49.0]; BMI 38.0 kg/m^2 [IQR 36.2–40.0]) (▶ **Fig. 1**). There were no significant demographic differences between groups (see **Table 1 s** in the online-only Supplementary material). The mean procedure duration was 38.9 minutes (SD 4.9), and there were no serious adverse events.

Measures of hepatic steatosis

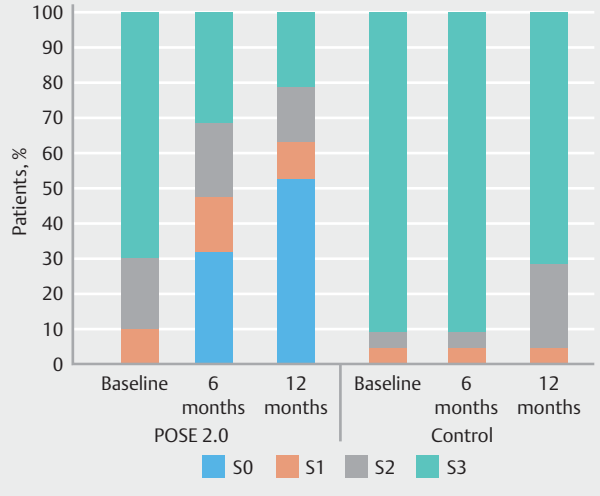
In the POSE 2.0 arm, mean CAP improved from 322.7 dB/m (95 %CI 302.4 to 342.9) at baseline to 259.5 dB/m (95 %CI 233.8 to 285.2) and 235.5 dB/m (95 %CI 209.3 to 261.7) at 6 and 12 months, respectively ($P < 0.001$). In contrast, the control arm presented CAP of 338.6 dB/m (95 %CI 322.3 to 354.9), 326.8 dB/m (95 %CI 312.4 to 341.3), and 320.9 dB/m (95 %CI 304.9 to 336.8) at baseline, 6, and 12 months, respectively ($P = 0.24$). The mean change in CAP was −88.8 dB/m (95 %CI −110.2 to −67.3) in the POSE 2.0 arm vs. −17.6 dB/m (95 %CI −35.7 to 0.5) in the control arm ($P < 0.001$). There were no significant changes in liver stiffness (▶ **Table 1**).

Among patients undergoing POSE 2.0, 6/19 (31.6 %) achieved S0 steatosis at 6 months, and 10/19 (52.6 %) achieved S0 steatosis at 12 months. None of the patients undergoing POSE 2.0 experienced progression in steatosis during the study period. In contrast, none of the control patients achieved S0 steatosis at 6 or 12 months. Resolution of steatosis occurred more frequently with POSE 2.0 than with lifestyle modification alone at both 6 ($P = 0.02$) and 12 months ($P < 0.001$) (▶ **Fig. 2**). All patients experienced stable or improved fibrosis stages in both arms at 6 and 12 months, except for one patient in the POSE 2.0

▶ **Table 1** Imaging outcomes of the primary obesity surgery endoluminal 2.0 (POSE 2.0) procedure versus control.

	Baseline	6 months	12 months	Within-group *P* value	Change at 12 months
a) Liver stiffness by transient elastography, mean (95 %CI), kPa					
POSE 2.0	5.55 (4.22 to 6.89)	5.53 (4.57 to 6.49)	5.51 (4.85 to 6.16)	0.98[1]	−0.08 (−1.24 to 1.08)
Control	5.19 (4.25 to 6.12)	5.14 (4.43 to 5.85)	4.87 (4.35 to 5.40)	0.46[1]	−0.37 (−1.30 to 0.56)
Between-group *P* value	1.0[2]	0.81[2]	0.26[2]		0.62[2]
b) CAP, mean (95 %CI), dB/m					
POSE 2.0	322.65 (302.38 to 342.92)	259.53 (233.84 to 285.22)	235.47 (209.30 to 261.65)	<0.001[1,3]	−88.79 (−110.23 to −67.34)
Control	338.59 (322.33 to 354.85)	326.82 (312.38 to 341.25)	320.86 (304.87 to 336.84)	0.24[1]	−17.62 (−35.71 to 0.47)
Between-group *P* value	0.19[2]	<0.01[2]	<0.01[2]		<0.001[2]
c) Distribution of hepatic fibrosis stages for POSE 2.0 and controls at baseline, 6 months, and 12 months, n (%)					
	POSE 2.0			Controls	
	Baseline (n = 20)	6 months (n = 19)	12 months (n = 19)	Baseline (n = 22)	6 months (n = 22)	12 months (n = 21)
F0–F1 fibrosis	17 (85.0)	16 (84.2)	16 (84.2)	20 (91.0)	20 (91.0)	21 (100)
F2 fibrosis	0 (0.0)	1 (5.3)	3 (15.8)	0 (0.0)	1 (4.5)	0 (0.0)
F3 fibrosis	3 (15.0)	2 (10.5)	0 (0.0)	2 (9.0)	1 (4.5)	0 (0.0)

POSE 2.0, primary obesity surgery endoluminal 2.0; CAP, controlled attenuation parameter.
[1] Repeated-measures analysis of variance.
[2] Mann-Whitney *U* test for independent samples.
[3] General linear model: *P* <0.001 for baseline vs. 6 months and baseline vs. 12 month.



▶ **Fig. 2** Distribution of stages of hepatic steatosis between primary obesity surgery endoluminal 2.0 (POSE 2.0) and controls at baseline, 6 months, and 12 months.

arm who experienced worsening of fibrosis from 4.8 kPa (F0–F1) to 8.3 kPa (F3) at 12 months (▶ **Table 1**).

Throughout follow-up, POSE 2.0 patients presented significant improvements in liver biochemical parameters of NAFLD, including aspartate aminotransferase, alanine aminotransferase, and HSI and APRI scores (▶ **Table 2**). In contrast, only the HSI score improved in the control arm. Nevertheless, this change was more significant in the POSE 2.0 arm than in the control arm ($P = 0.002$) (▶ **Table 2**). Neither group had any significant changes in lipid profile or thyroid function (**Table 2 s**).

Measures of obesity, insulin resistance, and patient-reported outcomes

In the POSE 2.0 arm, mean BMI improved from 37.9 kg/m^2 (95 %CI 36.7 to 39.1) at baseline to 31.6 kg/m^2 (95 %CI 29.1 to 33.5) at 12 months ($P<0.001$) (**Table 3 s**). Mean BMI also improved in the control arm, from 38.4 kg/m^2 (95 %CI 37.1 to 39.7) at baseline to 36.8 kg/m^2 (95 %CI 35.1 to 38.3) at 12 months ($P = 0.01$). At 12 months, the mean BMI was statistically lower in the POSE group ($P<0.001$). The mean %TBWL was 18.0 (95 %CI 15.1 to 20.9) at 6 months and 17.5 (95 %CI 12.2 to 23.0) at 12 months in the POSE 2.0 arm compared with 4.5 (95 %CI

▶ **Table 2** Laboratory outcomes of primary obesity surgery endoluminal 2.0 (POSE 2.0) versus control.

	POSE 2.0: Comparison of variables between baseline, 6 months, and 12 months (mean, 95%CI)						Control: Comparison of variables between baseline, 6 months, and 12 months (mean, 95%CI)				
Variable	**Baseline (n = 20)**	**6 months (n = 19)**	**12 months (n = 19)**	**Within group *P* value**	**Change at 12 months**	**Change between groups 12 months**	**Baseline (n = 22)**	**6 months (n = 22)**	**12 months (n = 21)**	**Within group *P* value**	**Change at 12 months**
AST, U/L	28.75 (24.81 to 32.69)	18.18 (15.95 to 20.41)	22.03 (17.03 to 27.03)	**<0.001**[1,2]	−7.81 (−13.15 to −2.47)	**0.024**[3]	24.14 (20.45 to 27.82)	22.95 (19.09 to 26.82)	23.72 (19.89 to 27.55)	0.89[1]	−0.66 (−4.10 to 2.77)
ALT, U/L	40.90 (29.23 to 52.57)	21.53 (16.53 to 26.52)	23.48 (18.34 to 28.63)	**0.001**[1,2]	−18.20 (−29.89 to −6.51)	**0.033**[3]	40.91 (28.48 to 53.33)	36.86 (25.16 to 48.57)	34.48 (22.61 to 46.34)	0.73[1]	−7.05 (−13.91 to −0.18)
ALP, U/L	62.73 (56.71 to 68.76)	62.80 (57.53 to 68.07)	61.69 (55.41 to 67.96)	0.95[1]	−1.61 (−8.31 to 5.08)	0.66[3]	75.85 (61.66 to 90.04)	80.33 (65.59 to 95.06)	77.17 (63.73 to 90.62)	0.89[1]	0.72 (−8.39 to 9.82)
Platelets, $\times 10^3/\mu L$	261.45 (227.45 to 295.45)	268.37 (236.85 to 299.89)	270.63 (238.41 to 302.85)	0.90[1]	5.26 (−15.25 to 25.77)	0.53[3]	274.77 (246.35 to 303.20)	276.41 (250.69 to 302.13)	288.24 (256.74 to 319.74)	0.76[1]	13.62 (−5.17 to 32.41)
HSI score	49.96 (47.55 to 52.37)	–	41.23 (37.65 to 44.81)	<0.001[5]	−11.16 (−17.03 to −5.29)	**0.002**[4]	51.87 (49.93 to 53.81)	–	48.46 (45.90 to 51.02)	**0.01**[5]	−3.29 (−5.71 to −0.87)
APRI score	0.29 (0.24 to 0.34)	–	0.20 (0.16 to 0.24)	0.001[4]	−0.09 (−0.14 to −0.04)	**0.006**[4]	0.23 (0.19 to 0.27)	–	0.22 (0.17 to 0.26)	0.39[5]	−0.01 (−0.05 to 0.02)
FIB-4 score	0.63 (0.48 to 0.78)	–	0.57 (0.44 to 0.70)	0.36[4]	−0.07 (−0.19 to 0.04)	0.29[3]	0.59 (0.46 to 0.72)	–	0.60 (0.46 to 0.73)	0.85[5]	0.01 (−0.10 to 0.12)
HOMA-IR score	4.02 (2.42 to 5.62)	–	3.07 (0.41 to 5.74)	0.066[5]	−0.99 (−4.12 to 2.14)	0.23[4]	7.46 (0.84 to 14.09)	–	4.18 (2.78 to 5.58)	0.43[5]	−3.49 (−10.37 to 3.40)

AST, aspartate aminotransferase; ALT, alanine aminotransferase; ALP, alkaline phosphatase; HSI, hepatic steatosis index; APRI, AST to platelet ratio; FIB-4, fibrosis-4; HOMA-IR, homeostatic model assessment for insulin resistance.
[1] Repeated-measures analysis of variance.
[2] General linear model: $P < 0.01$ for baseline vs. 6 months and $P < 0.05$ for baseline vs. 12 months.
[3] Independent sample *t* test.
[4] Paired samples Student's *t* test.
[5] Wilcoxon signed-rank test for paired samples.

2.0 to 7.0) and 4.0 (95 %CI 2.0 to 7.0) at 6 and 12 months, respectively, in the control arm. At 6 and 12 months, the %TBWL was significantly higher in the intervention group than in the control group ($P<0.001$). In the POSE 2.0 arm, 100 % and 73.7 % achieved ≥ 10 %TBWL at 6 and 12 months, respectively, compared with 18.2 % and 23.8 % in the control arm. In the POSE 2.0 arm, 68.4 % and 57.9 % achieved ≥ 15 %TBWL at 6 and 12 months, respectively, compared with 0 % and 4.8 % in the control arm.

POSE 2.0 patients experienced improvements in glycated hemoglobin, insulin, and 2-hour postprandial glucose level, and a trend toward improvement in the homeostatic model assessment for insulin resistance score ($P=0.07$). No changes in insulin resistance and glucose homeostasis were observed in the control arm (**Table 4 s**).

Patients in the POSE 2.0 arm presented an overall improvement in their Three-Factor Eating Questionnaire 18 scores, driven by an improvement in the uncontrolled eating subscore (**Table 5 s**); we observed no improvements in the questionnaire scores of patients following lifestyle modification alone. Patients in the POSE 2.0 arm showed improvement in the bloating subscores of the Gastroparesis Cardinal Symptom Index questionnaire, but no other significant changes were documented (**Table 6 s**).

Discussion

This prospective, single-center, pragmatic study represents the first prospective assessment of the POSE 2.0 procedure in the management of NAFLD and obesity. Patients undergoing POSE 2.0 achieved notable and superior improvements in sonographic and biochemical measures of hepatic steatosis, obesity, and insulin resistance compared with a similar cohort of adults motivated to lose weight through high-intensity lifestyle modification alone.

Endoscopic sleeve gastroplasty, a similar gastric remodeling procedure, has shown promising results in NAFLD management [5, 6, 11, 12], mirroring the results from our study [5]. Intragastric balloons have similarly demonstrated improvements in patients with NAFLD by multiple measures, including histologic activity [13, 14], transaminases [13–15], imaging-based hepatic steatosis [15], and serum glucose and insulin [13, 15]. The current study adds prospective controlled evidence to support the use of endoscopic bariatric and metabolic therapies such as POSE 2.0 for NAFLD management, as the majority of our interventional patients reached the critical threshold of ≥ 10 %TBWL associated with histologic steatohepatitis resolution and regression of fibrosis [3, 16]. Of note, one POSE 2.0 patients had worsened fibrosis from F0–F1 to F3 at 1 year, which indicates that liver surveillance is warranted.

Mechanisms of NAFLD improvement are understood to involve weight-dependent and weight-independent pathways, with the latter pathway likely to involve insulin resistance, inflammation, and incretin imbalances, among others [4]. The POSE 2.0 procedure is a restrictive gastric remodeling technique that affects appetite and results in metabolic improvements through weight-loss-dependent pathways [7]. Thus, future management can combine this procedure with small-intestinal endoscopic bariatric and metabolic therapies and or metabolically active pharmacotherapies, such as glucagon-like peptide 1 receptor agonists in tandem or in sequence as a chronic disease management paradigm for NAFLD [17].

One strength of this study is its pragmatic real-world design. A frequent limitation of randomized clinical trials assessing weight loss interventions is that patients are randomly allocated to a particular intervention that may not be their preference, limiting generalizability and affecting compliance. Our pragmatic design permitted patients who were highly motivated to lose weight through lifestyle means to self-allocate to the control arm, further validating the robust differences in outcomes favoring POSE 2.0 over lifestyle modification alone [8].

One major limitation of this study is the lack of histologic assessment. Although NAFLD is a prevalent diagnosis, the subset of patients with NASH and liver fibrosis is at an elevated risk for progression and overall mortality [18]. As NASH is a histologic diagnosis, recognizing this at-risk subset can only be achieved with liver biopsy. Nevertheless, liver biopsies have the limitations of sampling errors and invasiveness. In NAFLD, liver biopsies are not commonly used clinically, as reflected in published endoscopic and surgical articles using an approach similar to ours [5]. Moreover, we could further mimic real-world scenarios, reduce invasiveness, and increase patient compliance by not using liver biopsies for research purposes only. Our primary outcome, CAP, is a widely used, reproducible, practical biomarker for identifying and stratifying steatosis, with an area under the curve of 0.87 for ≥ S1, 0.77 for ≥ S2, and 0.70 for ≥ S3 [19]. HSI has high sensitivity (93 %) and specificity (92 %) for NAFLD, and the relevance of APRI in NAFLD is shown by its correlation with mortality [20]. Furthermore, nearly 75 % of patients in the POSE 2.0 arm achieved ≥ 10 %TBWL, the threshold of weight loss linked to NASH resolution [3], suggesting that POSE 2.0 is likely to benefit patients with NASH and simple steatosis in the context of metabolic disease. Finally, the degree of engagement and commitment could not be measured, which limits to some extent the generalizability of our results.

A separate limitation of this study is that most patients did not have elevated liver stiffness at baseline. While the goal of such interventions would be to address NAFLD before it reaches advanced stages, those with advanced fibrosis represent a population at high risk for progression to cirrhosis and thus warrant further attention. Finally, given that most improvements in NAFLD were correlated with amelioration in obesity-related outcomes, it is unclear whether POSE 2.0 would be helpful for nonobese NAFLD patients.

In conclusion, our data show that the POSE 2.0 procedure was safe and effective in treating patients with NAFLD and obesity. Further studies are required to elucidate its role in subsets of patients with NASH, the physiologic mechanisms of NAFLD improvement, and the efficacy and safety for individuals with advanced fibrosis.

Acknowledgments

The authors would like to acknowledge Emirates Health Services, Ministry of Health, United Arab Emirates and USGI Medical (San Clemente, CA) for their support of the study. We would also like to acknowledge the following individuals Dr. Yousef Altair, Dr. Maryam AlNuaimi, Dr. Nasser Costandy Yosof, and Dr. Anthony Kerbage.

Competing Interests

B.K. Abu Dayyeh reports consultant roles with Endogenex, Endo-TAGSS, Metamodix, and BFKW; consultant and grant/research support from USGI, Apollo Endosurgery, Spatz Medical, Cairn Diagnostics, Aspire Bariatrics, Boston Scientific; Speaker roles with Olympus, Johnson and Johnson; and speaker and grant/research support from Medtronic, Endogastric solutions. A.C. Storm reports institutional research grants from Boston Scientific, Enterasense, Endogenex; consulting fees from Olympus; consulting fees and research grants from Endo-TAGSS, and Apollo Endosurgery; and participation in Data Safety Monitoring Board with GI Dynamics, and ERBE. M. AlKhatry, B. Rapaka, D.B. Maselli, D.M. Abboud, V.O. Brunaldi, T. Mahmoud, R. Ghazi, F. Abdul Razzak, K. Gala, I. Joudah, F. Housen, S. Al Qadi, and E.J. Vargas declare that they have no conflict of interest.

Funding

This study was supported by the UAE Ministry of Health and USGI Medical (San Clemente, CA) provided study devices for the study on a collaborative research agreement.

Clinical trial

Trial Registration: ClinicalTrials.gov | Registration number (trial ID): NCT05611567 | Type of study: Prospective, open-label, single center

References

[1] Byrne CD, Targher G. NAFLD: a multisystem disease. J Hepatol 2015; 62: S47–64

[2] Martins MJ, Ascensão A, Magalhães J et al. Molecular Mechanisms of NAFLD in Metabolic Syndrome. Biomed Res Int 2015; 2015: 621080

[3] Vilar-Gomez E, Martinez-Perez Y, Calzadilla-Bertot L et al. Weight loss through lifestyle modification significantly reduces features of non-alcoholic steatohepatitis. Gastroenterology 2015; 149: 367–378.e365, quiz e314-365

[4] Abu Dayyeh BK, Bazerbachi F, Graupera I et al. Endoscopic bariatric and metabolic therapies for non-alcoholic fatty liver disease. J Hepatol 2019; 71: 1246–1248

[5] Hajifathalian K, Mehta A, Ang B et al. Improvement in insulin resistance and estimated hepatic steatosis and fibrosis after endoscopic sleeve gastroplasty. Gastrointest Endosc 2021; 93: 1110–1118

[6] Jagtap N, Kalapala R, Katakwar A et al. Endoscopic sleeve gastroplasty – minimally invasive treatment for non-alcoholic fatty liver disease and obesity. Indian J Gastroenterol 2021; 40: 572–579

[7] Lopez Nava G, Arau RT, Asokkumar R et al. prospective multicenter study of the primary obesity surgery endoluminal (POSE 2.0) procedure for treatment of obesity. Clin Gastroenterol Hepatol 2023; 21: 81–89.e84

[8] Ford I, Norrie J. Pragmatic trials. N Engl J Med 2016; 375: 454–463

[9] Lopez-Nava G, Asokkumar R, Turró Arau R et al. Modified primary obesity surgery endoluminal (POSE-2) procedure for the treatment of obesity. VideoGIE 2020; 5: 91–93

[10] Pu K, Wang Y, Bai S et al. Diagnostic accuracy of controlled attenuation parameter (CAP) as a non-invasive test for steatosis in suspected non-alcoholic fatty liver disease: a systematic review and meta-analysis. BMC Gastroenterol 2019; 19: 51

[11] Abu Dayyeh BK, Bazerbachi F, Vargas EJ et al. Endoscopic sleeve gastroplasty for treatment of class 1 and 2 obesity (MERIT): a prospective, multicentre, randomised trial. Lancet 2022; 400: 441–451

[12] Hadefi A, Verset L, Pezzullo M et al. Endoscopic duodenal mucosal resurfacing for nonalcoholic steatohepatitis (NASH): a pilot study. Endosc Int Open 2021; 9: E1792–E1800

[13] Bazerbachi F, Vargas EJ, Rizk M et al. Intragastric balloon placement induces significant metabolic and histologic improvement in patients with nonalcoholic steatohepatitis. Clin Gastroenterol Hepatol 2021; 19: 146–154.e144

[14] Lee YM, Low HC, Lim LG et al. Intragastric balloon significantly improves nonalcoholic fatty liver disease activity score in obese patients with nonalcoholic steatohepatitis: a pilot study. Gastrointest Endosc 2012; 76: 756–760

[15] Folini L, Veronelli A, Benetti A et al. Liver steatosis (LS) evaluated through chemical-shift magnetic resonance imaging liver enzymes in morbid obesity; effect of weight loss obtained with intragastric balloon gastric banding. Acta Diabetol 2014; 51: 361–368

[16] Romero-Gómez M, Zelber-Sagi S, Trenell M. Treatment of NAFLD with diet, physical activity and exercise. J Hepatol 2017; 67: 829–846

[17] Badurdeen D, Hoff AC, Hedjoudje A et al. Endoscopic sleeve gastroplasty plus liraglutide versus endoscopic sleeve gastroplasty alone for weight loss. Gastrointest Endosc 2021; 93: 1316–1324.e1

[18] Hagström H, Nasr P, Ekstedt M et al. Fibrosis stage but not NASH predicts mortality and time to development of severe liver disease in biopsy-proven NAFLD. J Hepatol 2017; 67: 1265–1273

[19] Eddowes PJ, Sasso M, Allison M et al. Accuracy of FibroScan controlled attenuation parameter and liver stiffness measurement in assessing steatosis and fibrosis in patients with nonalcoholic fatty liver disease. Gastroenterology 2019; 156: 1717–1730

[20] Kim D, Kim WR, Kim HJ et al. Association between noninvasive fibrosis markers and mortality among adults with nonalcoholic fatty liver disease in the United States. Hepatology 2013; 57: 1357–1365