South African Journal of Clinical Nutrition 2024; 37(4):193–196
https://doi.org/10.1080/16070658.2024.2435699

SAJCN
ISSN 1607-0658 EISSN 2221-1268

CASE REPORT

Changes in hepatic volume and body composition following a two-week very low-calorie diet (VLCD) prior to a laparoscopic Nissen fundoplication

Francis-Mico Price[a] and **Francois Nicholaas Schutte**[b*]

[a]*Registered Dietitian, University of the Free State, Bloemfontein, South Africa*
[b]*Specialist Surgeon, Zuid-Afrikaans Hospital, Pretoria, South Africa*
**Correspondence: info@midlinedieticians.co.za*

An enlarged fatty liver makes laparoscopic surgery of the upper gastrointestinal tract (GIT) more technically challenging.[1] A 35-year-old female was referred to the dietitian for a preoperative very low-calorie diet (VLCD) to assist in decreasing hepatic volume and visceral adiposity. This case study highlights that the same benefits shown using preoperative VLCDs in bariatric patients as part of enhanced recovery after surgery (ERAS) guidelines can be observed in non-bariatric upper GIT surgery patients as well.[2] In a time period of two weeks on a VLCD, a 50.7% reduction in left hepatic lobe volume (LHLV) was observed, as well as 1.4 kg fat loss around the abdomen.

Keywords: laparoscopic surgery, Nissen fundoplication, hepatic volume, very low-calorie diet (VLCD)

Background

A 35-year-old female was scheduled to undergo a laparoscopic Nissen fundoplication to repair her hiatus hernia in a high-volume upper gastrointestinal (GIT) surgical unit in Pretoria, South Africa. As part of the surgeon's preoperative protocol, all patients scheduled for such surgery undergo an abdominal sonar to measure left hepatic lobe volume (LHLV). Upon assessment, it was determined that she had an enlarged fatty liver and was referred as an outpatient to the dietitian for implementation of a two- week preoperative very low-calorie diet (VLCD) to allow for decreasing LHLV.

The self-reported medical history indicated that the patient did not have hypertension, diabetes, or hypercholesterolaemia. She did not smoke, only consumed alcohol occasionally, and did not binge drink.

The study obtained ethical approval: UFS-HSD2024/2026/0110.

Assessments done prior to dietary intervention

Pre-dietary intervention abdominal sonar

To measure her LHLV during the pre-intervention abdominal sonar, the patient was asked to lie supine so the sonogram could be done via the subcostal or intercostal window.[3] Her liver was measured, and the LHLV was calculated at 456 ml using the formula to calculate the volume of an ellipsoid object.[3]

Pre-dietary intervention anthropometry

Routine anthropometric measurements were undertaken during the initial dietetic consultation with the patient, which took place just over two weeks prior to the scheduled surgery date (Table 1). The patient's height was ascertained using a stadiometer, and her body composition analysis was done using bioelectric impedance analysis (BIA) with an InBody 120® scale (InBody Co. Ltd, Seoul, Korea). Waist circumference was measured using a non-elastic measuring tape at the narrowest part of the abdomen between the lowest rib and the iliac crest.[4]

Pre-dietary intervention urine ketone analysis

The patient was asked to provide a urine sample and Medi-Test Combi 9 urine dipsticks were used to detect urine ketones.

Dietary intervention

During the consultation with the dietitian, the patient was educated on the reasoning for placing her on a VLCD meal plan and was given the food-based two-week preoperative VLCD consisting of 800 kcal per day. The meal plan comprised 40% protein, 25% carbohydrate, and 35% fats. An exchange list portion-sized meal plan was given to the patient and a seven-day sample menu. The meal plan comprised one starch exchange, one starchy vegetable exchange, eight protein exchanges, and one fat exchange. There was no limitation to the amount of non-starchy vegetables included. The dietary guidelines also indicated that all drinks consumed should be sugar-free, and two litres of water should be included daily. Alcohol consumption was also to be avoided. The patient was instructed to start the meal plan 14 days before her surgery.

Assessments done post-dietary intervention

Post-dietary intervention abdominal sonar

The patient underwent a repeat abdominal sonar on the day of her surgery, and using the same technique her LHLV was calculated to be 225 ml. Her LHLV decreased by 50.7% following a two-week VLCD.

Post-dietary intervention anthropometry

Repeat BIA and waist circumference measurement was done on the day of the surgery to determine the changes in body composition and waist circumference, respectively (Table 1). Following the two-week VLCD intervention, the patient lost 4.1 kg and had a body fat mass loss of 2.2 kg. Her waist circumference decreased by 4.7 cm, and she lost 1.4 kg of fat around the abdomen.

Table 1: Changes seen in anthropometric measurements

Factor	Baseline measurements	Post-dietary intervention measurements	Changes observed post-VLCD
Weight (kg)	76.9	72.8	−4.1
Body Mass Index (BMI) (kg/m^2)	31.2	29.5	−1.7
Body fat mass (kg)	35.7	33.8	−2.2
Muscle mass (kg)	22.7	21.3	−1.4
Visceral fat score	19	18	−1
Fat around the abdomen (kg)	18.7	17.6	−1.4
Waist circumference (cm)	101.7	97	−4.7

Post-dietary intervention urine ketone analysis

The ward completed a urine sample test prior to surgery, and no urine ketones were detected. This indicates that she did not enter ketosis after following the two-week VLCD. The measurement of urinary ketones was intended to be used as an indicator of meal plan compliance, as we expected the patient to enter ketosis. Self-reported compliance with the meal plan was 75–100%.

Surgical intervention

The patient underwent a laparoscopic Nissen fundoplication procedure where incisions were made for 4 x 10 mm trocars and one 5 mm incision for insertion of the Nathanson retractor. The operating time, from inserting the first trocar to removing the last trocar, was 22 minutes.

Discussion

Laparoscopic Nissen fundoplication is a surgical technique done for the treatment of gastroesophageal reflux disease (GERD).[5] It involves a hiatus hernia repair and an anti-reflux procedure using a 360-degree fundoplication with posterior closure of the crura.[5] For the surgeon to easily access the hiatus, the patient is placed into a steep anti-Trendelenburg position and a Nathanson retractor is used to elevate the part of the liver left of the falciform ligament.[5] Difficulty accessing the oesophagogastric junction and risk of hepatic injury may result in an unnecessarily technically challenging surgery, a higher incidence of conversions to open surgery, as well as intraoperative and perioperative complications.[4,6,7] Several patient characteristics can hinder this access, including hepatomegaly and visceral adiposity.[8]

Obesity is commonly associated with hepatomegaly due to non-alcoholic fatty liver disease (NAFLD), or, as it has recently been named, metabolic dysfunction associated steatotic liver disease (MASLD).[9,10] However, individuals with a healthy body mass index (BMI) may still develop MASLD, commonly referred to as non-obese or lean MASLD, usually related to various metabolic risk factors.[11] Overnutrition and a sedentary lifestyle are some of the lifestyle factors that lead to weight gain, obesity, visceral adiposity, and hepatic steatosis.[12] Research indicates that dietary factors such as increased glucose, fructose, and saturated fat intake result in hepatic *de-novo* lipogenesis as well as inflammation and insulin resistance in the adipose tissue and liver.[12]

Hepatomegaly, as a result of hepatic steatosis, results in an enlarged fatty liver that bleeds easily and is prone to injury due to the constant need for readjustment of the retractor during laparoscopic surgery (Figure 1).[13,14]

Hepatic steatosis is known to be reversible with weight loss, and preoperative VLCDs have been widely studied and implemented in patients undergoing bariatric surgery to decrease both hepatomegaly and visceral adiposity (Figure 2a and b).[9,15] A VLCD is defined as a diet consisting of ≤ 800 kcal per day.[15] However, it is important to keep in mind that a reduction in hepatic volume is attributed to weight loss in general and is not dependent on the specific type of diet.[16] A systematic review by van Wissen *et al*. (2016), included seven studies that investigated the effects of preoperative calorie restriction on hepatic volume. These studies found that low-calorie diets (LCD) can reduce the hepatic volume by 2.4% per week.[17] An LCD is defined as consisting of between 800 and 1 500 kcal/day.[18] The amount of protein, carbohydrates, and fats in a preoperative nutritional meal plan is important in reducing hepatic volume. Low-carbohydrate diets commonly result in weight loss and decreased intrahepatic triglyceride levels and are therefore often used for the management of NAFLD.[16] High-protein diets can promote weight loss, but few studies explain the relationship between protein intake and NAFLD.[16,19] Bortolotti *et al*. (2011) showed that supplementing the diet with 60 g of whey protein per day for 30 days without energy restrictions resulted in a decrease in visceral fat and hepatic volume.[16,19]

As with use in bariatric surgery enhanced recovery after surgery (ERAS) guidelines, the use of a preoperative VLCD has been applied in this non-bariatric surgical case as the same benefits can be observed.[2] Implementing a preoperative VLCD is intended to assist in the loss of predominantly fat mass (1.0 to 1.5 kg/ week) while preserving lean muscle mass.[20]

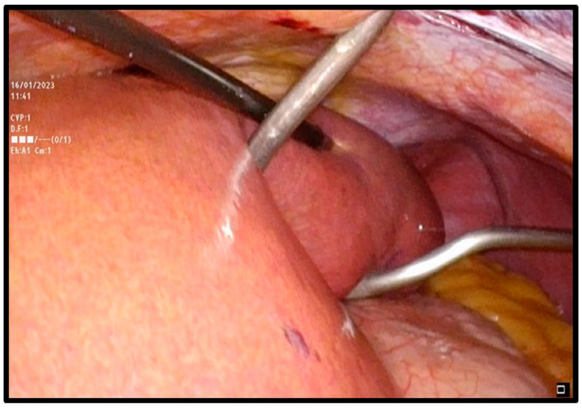

Figure 1: An enlarged left hepatic lobe with visible signs of hepatic steatosis posing a challenge for the surgeon to lift with the Nathanson retractor to access the oesophagogastric (EG) junction. Note: Images used with permission from the photographer and are intended for educational purposes only.

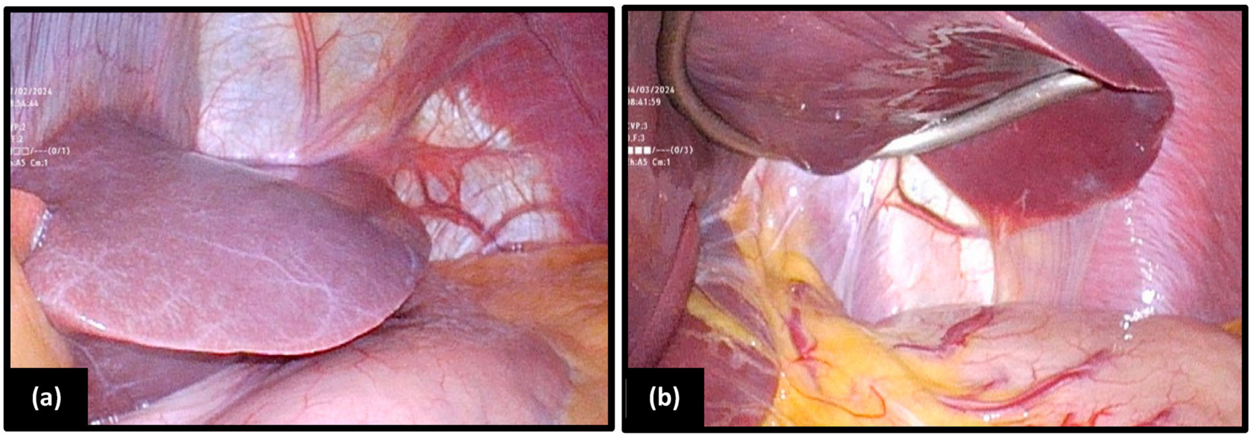

Figure 2: (a) A left hepatic lobe after a patient has been on a two-week very low-calorie diet (VLCD) to decrease hepatic steatosis. (b) A liver such as this is easier for the surgeon to lift with the Nathanson retractor to access the oesophagogastric (EG) junction. Note: Images used with permission from the photographer and are intended for educational purposes only.

The results in the current case study echo the results of a prospective study done by Sivakumar *et al.* (2019) where 60 participants were placed on a two-week preoperative meal replacement shake VLCD prior to bariatric surgery.[6] Body composition analysis was completed both before and after the dietary intervention using a dual-energy X-ray absorptiometry (DXA) scanner.[6] The results indicated a significant weight reduction: mean (±SD) decrease of 4.5 ± 2.3 kg and a reduction of body fat mass by mean (±SD) 1.7 (±1.4) kg. Lean muscle mass was decreased by a mean (±SD) of 2.8 (±2.2) kg.[6]

Similarly, a study done by Childs *et al*. (2022) included 17 participants placed on an LCD consisting of food and meal replacement shakes for a period of two to eight weeks.[18] In that study, Childs *et al*. measured the change in total hepatic volume using both magnetic resonance imaging (MRI) and ultrasound. They concluded a 16% and 18% reduction, respectively, and observed that the greatest reduction in hepatic volume occurred within the first two weeks of the dietary intervention.[18] In the current case study, LHLV was decreased by 50.7% and it can be assumed that a reduction in LHLV indicates a reduction in total hepatic volume.[18]

The results of the study by Childs *et al*. (2022) indicate that it may not be necessary for a VLCD to be followed if similar results can be observed by following an LCD. This has been confirmed by a systematic review and meta-analysis done by Chowdhury *et al*. (2024), which included 21 studies in the review and 20 studies in the meta-analysis of obese patients placed on an LCD and VLCDs prior to benign upper gastrointestinal surgery.[21] The results indicated that whilst a preoperative VLCD is effective in reducing hepatic volume and weight, there was no statistically significant difference noted in following a preoperative LCD.[21] An LCD may allow for greater compliance with the prescribed meal plan, as it may be easier to follow.

Although this case study did not directly assess side effects, it is well documented that VLCDs can lead to common adverse effects such as headaches, dizziness, halitosis, and constipation.[20] These symptoms are primarily attributed to the diet's low carbohydrate content, which can induce a state of ketosis. A reduction in carbohydrate intake often also leads to decreased fibre intake, exacerbating the risk of constipation. To address these concerns, the sample menu incorporated low GI carbohydrate sources, various non-starchy vegetables, and a recommendation of two litres of water daily. Although the patient in this case study did not enter ketosis, the use of an LCD rather than a VLCD may further mitigate these side effects by providing a slightly higher carbohydrate and fibre intake, reducing the likelihood of ketosis and its associated symptoms.

Surgery such as done in this case study is usually not considered emergency surgery. If the surgeon can easily access the hiatus without repeated adjustment of the retractor or risk of hepatic injury, it can potentially result in a decrease in theatre time and perceived ease of the procedure, as well as a potential decrease in postoperative complications. The surgical benefits observed may justify the postponement of the surgery by two weeks to allow for significant decreases in hepatomegaly and visceral adiposity.

Disclosure statement – No potential conflict of interest was reported by the authors.

ORCID
Francis-Mico Price http://orcid.org/0000-0003-2533-0041

References
1. Lewis MC, Phillips ML, Slavotinek JP, et al. Change in liver size and fat content after treatment with Optifast® very low calorie diet. *Obes Surg*. 2006;16(6):697–701. https://doi.org/10.1381/096089206777346682
2. Stenberg E, dos Reis Falcão LF, O'Kane M, et al. Guidelines for perioperative care in bariatric surgery: enhanced recovery after surgery (ERAS) society recommendations: a 2021 update. *World J Surg*. 2022;46(4):729–751. https://doi.org/10.1007/s00268-021-06394-9
3. Kitajima K, Taboury J, Boleslawski E, et al. Sonographic preoperative assessment of liver volume before major liver resection. *Gastroenterol Clin Biol*. 2008;32(4):382–389. https://doi.org/10.1016/j.gcb.2008.02.007
4. Colles SL, Dixon JB, Marks P, et al. Preoperative weight loss with a very-low-energy diet: Quantitation of changes in liver and abdominal fat by serial imaging. *Am J Clin Nutr*. 2006;84(2):304–311. https://doi.org/10.1093/ajcn/84.2.304
5. Kevin S, Bittar K, Siccardi MA. Nissen Fundoplication – StatPearls – NCBI Bookshelf. 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK519521/ [accessed 12 August 2024].
6. Sivakumar J, Chong L, Ward S, et al. Body Composition Changes Following a Very-Low-Calorie Pre-Operative Diet in Patients Undergoing Bariatric Surgery. *Obes Surg*. 2020;30(1):119–126. https://doi.org/10.1007/s11695-019-04174-y

7. Griffin SB, Ross LJ, Burstow MJ, et al. Efficacy of a dietitian-led very low calorie diet (VLCD) based model of care to facilitate weight loss for obese patients prior to elective, non-bariatric surgery. *J Hum Nutr Diet*. 2021;34(1):188–198. https://doi.org/10.1111/jhn.12819
8. Griffin SB, Palmer MA, Strodl E, et al. Elective surgery in adult patients with excess weight: Can preoperative dietary interventions improve surgical outcomes? A systematic review. *Nutrients*. 2021;13(11):3775. https://doi.org/10.3390/nu13113775
9. Diab S, Bertin JB, Simeu B, et al. Impact of preoperative protein sparing modified fast diet on bariatric surgery. *Obes Surg*. 2023;33(1):17–24. https://doi.org/10.1007/s11695-022-06361-w
10. Rinella ME, Lazarus JV, Ratziu V, et al. A multi-society Delphi consensus statement on new fatty liver disease nomenclature. *Hepatology*. 2023;Publish Ah.
11. Powell EE, Wong VW sun, Rinella M. Non-alcoholic fatty liver disease. Lancet. 2021;397(10290):2212–2224. http://dx.doi.org/10.1016/S0140-6736(20)32511-3
12. Stefan N, Häring HU, Cusi K. Non-alcoholic fatty liver disease: causes, diagnosis, cardiometabolic consequences, and treatment strategies. Vol. 7, The Lancet Diabetes and Endocrinology. 2019. p. 313–324.
13. Schiavo L, Pilone V, Rossetti G, et al. A 4-week preoperative ketogenic micronutrient-enriched diet is effective in reducing body weight, left hepatic lobe volume, and micronutrient deficiencies in patients undergoing bariatric surgery: a prospective pilot study. *Obes Surg*. 2018;28(8):2215–2224. https://doi.org/10.1007/s11695-018-3145-8
14. Williams SB, Matin SF, Matin S, et al. Implementation of a very low calorie diet in patients undergoing urologic surgery: room for improvement? *Clin Genitourin Cancer*. 2015;13(4):e203–204. https://doi.org/10.1016/j.clgc.2014.12.013
15. Khemtong A, Shantavasinkul PC, Boonchaya-Anant P, et al. Effect of preoperative very low-calorie diets on hepatic steatosis, fibrosis, and perioperative outcomes of bariatric surgery. *J Laparoendosc Adv Surg Tech*. 2024;34(3):219–226. https://doi.org/10.1089/lap.2023.0391
16. Fan JG, Cao HX. Role of diet and nutritional management in non-alcoholic fatty liver disease. *J Gastroenterol Hepatol*. 2013;28(S4):81–87. https://doi.org/10.1111/jgh.12244
17. van Wissen J, Bakker N, Doodeman HJ, et al. Preoperative methods to reduce liver volume in bariatric surgery: a systematic review. *Obes Surg*. 2016;26(2):251–256. https://doi.org/10.1007/s11695-015-1769-5
18. Childs J, Mudge LA, Esterman A, et al. What is the optimal time on a low-calorie diet prior to laparoscopic anti-reflux surgery? A prospective case-controlled study. *J Gastrointest Surg*. 2022;26(11):2249–2254. https://doi.org/10.1007/s11605-022-05438-2
19. Duarte SMB, Stefano JT, Vanni DS, et al. Impact of current diet at the risk of non-alcoholic fatty liver disease (NAFLD). *Arq Gastroenterol*. 2019;56(4):431–439. https://doi.org/10.1590/s0004-2803.201900000-67
20. Delbridge E, Proietto J. State of the science: VLED (Very Low Energy Diet) for obesity. *Asia Pac J Clin Nutr*. 2006;15(SUPPL. 1):49–54.
21. Chowdhury N, Hasnan S, Ullah S, et al. Low-calorie diets are effective for weight loss in patients undergoing benign upper gastrointestinal surgery: a systematic review and meta-analysis. *Surg Endosc*. 2024;38(8):4171–4185. https://doi.org/10.1007/s00464-024-11016-1

Received: 22-11-2024 Accepted: 22-11-2024