The benefits of preoperative low carbohydrate diets alongside lifestyle changes.

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Disclaimer: This blog is intended for health care professionals and others supporting people preparing for surgery. Low carbohydrate diets can be rapidly effective in reducing blood pressure, body mass and improving diabetes. Patients taking medications that lower blood pressure or glucose should have careful monitoring to reduce the risk of hypotension or hypoglycaemia and reductions of medication doses, including insulin, should be anticipated.

Lay summary

There is evidence that low carbohydrate diets work to reduce obesity and can reverse type 2 diabetes. This is because all 'starchy' carbohydrates (pasta, bread, potatoes) are converted to sugar and then fat, with a spike of the hormone insulin that makes you feel hungry again rapidly and stops you burning fat. The body prefers to use sugar as fuel and during starvation (including planned low-calorie diets) it breaks down protein – primarily your own muscles. Eating low carbohydrate diets (LCD) means you feel less hungry, and your body is more able to burn fat and less likely to use your protein stores. LCD may be good in the perioperative period to make anaesthetics safer, to reduce complications from diabetes and to allow muscle to be preserved. People who are on tablets to reduce blood pressure or blood sugar may need to reduce these if they start a LCD.

Summary

There is mounting evidence and growing acceptance that low-carbohydrate diets (LCDs) can improve glycaemic control, reducing medication dosing requirements and HbA1c in people with diabetes, and reduce body mass in people with obesity as effectively as standard low-calorie, low-fat diets, while being tolerable and sustainable for many. Notably, early reduction of visceral fat from abdominal and airway depots, and relative preservation of muscle mass, are potentially of great benefit in the perioperative period. Improvement of glycaemic control and lowering of blood pressure may be evident prior to significant weight loss. However, evidence of the effects of low-carbohydrate diets in the perioperative setting is currently lacking and must be translated from that obtained in other domains.

Overview: preparing well for surgery

People who prepare well for surgery have a better chance of avoiding a complication and reducing their post-operative length of stay. The Centre for Perioperative Care (CPOC) has defined optimal preoperative preparation in key domains [1]. CPOC recommends collaborative approaches to address dietary quality and lifestyle factors, including exercise, with specific goals including weight loss and improved diabetic control to improve patient safety, and reduce cancellations and length of stay. However, many find traditional low-calorie diets difficult to sustain, due to hunger and lack of energy to exercise.

Preoperative nutritional preparation: low carbohydrate as an option

LCD have had a resurgence in popularity and clinical use in recent times. Notably, the American Diabetes Association declared that "*reducing overall carbohydrate intake for individuals with diabetes has demonstrated the most evidence for improving glycemia*" [2], the UK's Scientific Advisory Committee on Nutrition recommended that "*for adults living with type 2 diabetes and overweight or obesity, a lower carbohydrate diet can be recommended by clinicians as an*

effective short-term option" [3]. and the Royal College of General Practitioners supports an e-learning course about the physiology of, evidence for and implementation of a LCD in type 2 diabetes. Indeed, as LCD become more prevalent for an increasingly wide range of indications, perioperative practitioners will encounter patients already established on LCD and must allow for its continuation as a patient choice, pre- and postoperatively. One of us has recently published a blog about nutrition on the CPOC Nutrition webpage [4] including some pointers to the benefits of low carbohydrate diets (LCD) and intermittent fasting (IF) as options that may be considered, and these are elaborated below.

What is a low carbohydrate diet?

Low carbohydrate diets (LCD) are defined as less than 130 grams carbohydrate per day[5] and include adequate protein and healthy fat. This is in contrast to the UK Government's 'EatWell guide'[6], which recommends around 50% of calories from carbohydrates (i.e. more than 250 or 330 grams per day, for women and men respectively. Many versions of LCD are possible, to suit individual preferences. For example, a 'Ketogenic diet' includes less than 50 grams of carbohydrate per day. Initially, some find it useful to use one of a variety of macronutrient tracking apps, until the LCD eating pattern is familiar (see resources below or search an app store).

How do low carbohydrate diets work?

When complex carbohydrates, such as pasta, potatoes and bread, are eaten they are metabolised to simple sugars, such as glucose, ultimately to be oxidised or stored as glycogen, while any excess is converted to fat. Eating foods that contain carbohydrate (and to a lesser extent, protein) leads to an insulin response which inhibits lipolysis (fat breakdown) and enhances glucose storage. The insulin response to glycaemic foods may cause a late reduction in blood glucose while lipid stores are inaccessible, thus contributing to hunger [7]. The 'Carbohydrate Insulin Model' [8] is a theoretical mechanism to explain why a high-carbohydrate energy-restricted diet approach may be ineffective at sustaining weight loss or reducing HbA1c. By contrast, protein and fat both produce a sensation of fullness and lasting satiety without inhibition of lipolysis. LCD, which include healthy fats and adequate protein, support access to lipid stores between meals and during the fasting state, thus reducing hunger and the need to snack between meals. As fasting tolerance is naturally increased, many people using LCD report spontaneous deferral of breakfast, or fewer meals altogether, termed 'intermittent fasting' (IF). This maintains a prolonged low-insulin state, further enhancing lipolysis ('fat burning'). Surgical patients who have adapted to LCD and IF are more likely to tolerate fasting in hospital while waiting for surgery, without distressing hunger symptoms.

Do LCDs work?

LCD have been shown to:

- **Reduce blood sugar and HbA1c.** They contribute to sustained improvements in glycaemic control [9, 10, 11, 12, 13]. Glycaemia (blood sugar levels) may rapidly improve (within days), requiring careful monitoring and early medication dose adjustments, whereas HbA1c will reflect a change after several months.
- **Reduce weight**. LCD can achieve reductions in overall body mass [12, 13, 14, 15,]. Initial brisk weight loss at the onset of LCD may be attributed to liberation of water associated with glycogen stores and reduction of insulin-stimulated renal sodium retention[16].

- **Lose fat.** LCD supports early loss of visceral adipose tissue (VAT), due to enhanced fat oxidation, from the liver [12, 15,17] and tongue [18, 19, 20] and other airway-adjacent depots, leading to an improvement in resting lung volume, airway calibre and reduction in severity of Obstructive Sleep Apnoea. All of these reduce the risks associated with general anaesthesia.
- **Reduce high blood pressure.** LCD have been shown to improve blood pressure control, as lowered insulin levels reduce renal sodium retention [21].

Overall, any improvements, even if slight, in glycaemic control, obesity or fat distribution, and blood pressure can only be beneficial, potentially reducing cancellations before or on the day of surgery, reducing risks associated with the use of insulin infusions and other complications related to diabetes, and reducing anaesthetic risks related to airway and ventilation management. For example, CPOC's diabetes guideline [22] recommends referring patients with an HbA1c of over 69mmol/mol for optimisation, which often means their operation is postponed.

At initiation of LCD, careful monitoring and controlled reduction of anti-diabetic and anti-hypertensive medications is needed [23, 24]. A 'deprescribing flowchart' is available here [24].

LCDs seem to preserve muscle *during fasting or weight loss*
People who are accustomed to high carbohydrate diets cannot use fat stores well during the early fasting period. They have limited lipolytic flux, consume glycogen stores in the liver rapidly and are then dependent on proteolysis (from skeletal and smooth muscle, including gut) to supply gluconeogenic precursors to prevent hypoglycaemia, until lipolysis becomes established in later phases of fasting [25].

Lipolysis liberates not only free fatty acid (FFA) as a mobilised fuel, but also glycerol. During prolonged fasting, glycerol is converted to glucose (de-novo gluconeogenesis). This supplements glucose recycled from lactate. Most tissues adapt to the milieu of prolonged fasting by utilising fuels other than glucose, such as oxidation of FFA and their derivative ketones (so-called 'glucose sparing'). Hence, blood glucose remains available for processes where it is essential (obligate glycolytic cell types). In people established on LCD, glycogen stores are preserved during early fasting due to both peripheral glucose-sparing and the gluconeogenesis using glycerol liberated from adipose triglycerides.

Why is protein essential in the perioperative phase?
Protein is needed for the maintenance of muscle power and mobility, gut integrity, wound healing and to make antibodies. If patients consume endogenous protein as a fuel these functions may be impaired.

How might low carbohydrate diets affect insulin resistance and muscle *during surgery*?
There is an apparent insulin resistance associated with fasting. The physiological basis for this is peripheral glucose sparing. Insulin resistance together with the stress-response of surgery, exacerbates glucose intolerance, manifesting as hyperglycaemia after perioperative carbohydrate administration. Perioperative fasting and the surgical stress response together worsen glucose tolerance, while hyperglycaemia worsens complications during and after surgery. These risks are more pronounced in patients with prior insulin resistance or sarcopaenia (low amounts of muscle). During perioperative fasting and until feeding resumes

after surgery, it is essential to try to reduce protein loss. Enhanced Recovery after Surgery (ERAS) protocols [26] aim to reduce insulin resistance and protein loss by pre-operative carbohydrate loading, based on evidence that this ameliorates hepatic glycogen depletion during early fasting. However, these well-established ERAS resources assume by design that a baseline high carbohydrate diet is standard [27], and do not differentiate between sub-groups that had been established on high vs. LCD. LCD reduce daily surges in insulin and thereby reduce hyperinsulinaemia and insulin resistance, but there is currently a lack of evidence of their perioperative use. There may be a parallel with sport, in that participants on LCD do not require the high levels of carbohydrate intake that have become normalised [28].

What problems may be associated at initiation of low carbohydrate diets?
Early adaptation symptoms (dizziness, headache) are usually minor and self-limiting, and are less troublesome if good hydration is maintained. Exercise tolerance may initially feel impaired, but rapidly recovers – it is important to include exercise alongside LCD.

Which medication may need supervised early reduction?
Patients taking anti-diabetic or antihypertensive medication may need carefully supervised early reductions in doses, due to the risk of hypoglycaemia or hypotension, respectively. Hence, gliclazide and glifozins should be stopped and other medication down-titrated, particularly insulin, using Murdoch et al's guidance [23]. In clinical practice, many patients and clinicians are unaware how powerful these nutritional interventions can be and therefore may not realise the risks if medications are not preemptively adjusted when starting LCD.

Conclusion
Standard dietary approaches to achieve weight loss or to improve diabetes control are not always effective; indeed, no single approach can be expected to suit every patient. As LCD are now an accepted contribution to diabetes management in the UK, with evidence of benefit for weight loss, blood pressure and glycaemic control, and other potential perioperative advantages, patients ought to be informed of LCD as an option. Holistic preoperative services ought to be able to offer to LCD as an option.

Online resources:

- The Public Health Collaboration charity https://phcuk.org/
- CPOC-Blog about the Public Health Collaboration conference 2024: https://cpoc.org.uk/blog/public-health-collaboration-conference
- NHS Lowcarb program - https://www.lowcarbprogram.com/
- The Lifestyle Club – on-line coaching service https://www.thelifestyleclub.uk/
- Freshwell – LCD resources https://lowcarbfreshwell.com/
- Deprescribing guidelines - https://lowcarbfreshwell.com/documents/10/Deprescribing-Freshwell-Flow-Chart-v11.pdf
- Useful explanation of terms and processes https://www.briancolemd.com/wp-content/themes/ypo-theme/pdf/the-role-of-nutritional-supplementation-perioperative-care.pdf
- RCGP course: Type 2 diabetes and the low GI diet https://elearning.rcgp.org.uk/course/info.php?id=291

Books:

- Tom Watson. DOWNSIZING, How I lost 8 stone, reversed my diabetes and regained my health. 256pp. Kyle Books. 2020. ISBN-13: 978-0857838339
- Aseem Malhotra and Donal O'Neill. The Pioppi Diet: a 21-day Lifestyle Plan. 360pp. Penguin. ISBN 1405932635

References:

1 CPOC. The key to reducing waiting lists. 2024. https://www.cpoc.org.uk/guidelines-resources-resources/key-reducing-waiting-lists

2 American Diabetes Association: Facilitating Behavior Change and Well-being to Improve Health Outcomes: Standards of Medical Care in Diabetes—2022. https://diabetesjournals.org/care/article/45/Supplement_1/S60/138923/5-Facilitating-Behavior-Change-and-Well-being-to

3 Scientific Advisory Committee on Nutrition (SACN). Lower carbohydrate diets for adults with type 2 diabetes. 2021. https://www.gov.uk/government/publications/sacn-report-lower-carbohydrate-diets-for-type-2-diabetes

4 McNally CPOC: Nutrition-blog https://cpoc.org.uk/nutrition-perioperative-care-preparation-surgery-and-recovery-after-surgery

5 Feinman RD, et al. Dietary carbohydrate restriction as the first approach in diabetes management: Critical review and evidence base. Nutrition 31(1) 1-13, 2015 https://doi.org/10.1016/j.nut.2014.06.011

6 NHS Eatwell Guide https://www.nhs.uk/live-well/eat-well/ - full details at https://www.gov.uk/government/publications/the-eatwell-guide

7 McNally S. Obesity is a community issue, not just an individual one. BMJ 2023;380.702 https://doi.org/10.1136/bmj.p702

8 Magkos et al. On the pathogenesis of obesity: causal models and missing pieces of the puzzle. Nature Metabolism 2024

9 Hallberg S, et al. Reversing Type 2 Diabetes: A Narrative Review of the Evidence. Nutrients. 2019 Apr 1;11(4):766 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6520897/

10 Unwin D, et al. What predicts drug-free type 2 diabetes remission? Insights from an 8-year general practice service evaluation of a lower carbohydrate diet with weight loss. BMJ Nutrition, Prevention & Health 2023;6 https://doi.org/10.1136/bmjnph-2022-000544

11 VanZuuren E, et al. Effects of low-carbohydrate- compared with low-fat diet interventions on metabolic control in people with T2D: a sytematic review including GRADE assessments. American Journal of Clinical Nutrition, 108(2) 2018 300-31 https://doi.org/10.1093/ajcn/nqy096

12 Hansen CD, et al. Effect of Calorie-Unrestricted Low-Carbohydrate, High-Fat Diet Versus High-Carbohydrate, Low-Fat Diet on Type 2 Diabetes and Nonalcoholic Fatty Liver Disease: A Randomized Controlled Trial. Ann Intern Med.2023;176:10-21 https://doi.org/10.7326/M22-1787

13 Morris E, Aveyard P, Dyson P, Noreik M, Bailey C, Fox R, et al. A food-based, low-energy, low-carbohydrate diet for people with type 2 diabetes in primary care: A randomized controlled feasibility trial. Diabetes Obesity Metabolism [Internet]. 2020 Apr [cited 2024 Aug 28];22(4):512–20. https://dom-pubs.pericles-prod.literatumonline.com/doi/10.1111/dom.13915

14 Oliver D, Andrews K. Brief intervention of low carbohydrate dietary advice: clinic results and a review of the literature. Current Opinion in Endocrinology & Diabetes and Obesity 28(5):p

496-502, October 2021. https://journals.lww.com/co-endocrinology/fulltext/2021/10000/brief_intervention_of_low_carbohydrate_dietary.11.aspx
15 Thomsen MN, et al. Dietary carbohydrate restriction augments weight loss-induced improvements in glycaemic control and liver fat in individuals with type 2 diabetes: a randomised controlled trial. Diabetologia 65, 506–517 (2022) https://doi.org/10.1007/s00125-021-05628-8
16 Unwin D, Unwin J, Crocombe D, Delon C, Guess N, Wong C. Renal function in patients following a low carbohydrate diet for type 2 diabetes: a review of the literature and analysis of routine clinical data from a primary care service over 7 years. Curr Opin Endocrinol Diabetes Obes. 2021 Oct 1;28(5):469-479. PMID: 34468402. https://doi.org/10.1097/med.0000000000000658
17 Mardinoglu A, et al. An Integrated Understanding of the Rapid Metabolic Benefits of a Carbohydrate-Restricted Diet on Hepatic Steatosis in Humans. Cell Metabolism, 27(3)559 - 571.e5 https://doi.org/10.1016/j.cmet.2018.01.005
18 Kim AM et al. Tongue Fat and its Relationship to Obstructive Sleep Apnea. Sleep 37(10) 1639–1648; 2014 https://doi.org/10.5665/sleep.4072
19 Wang SH, et al. Effect of Weight Loss on Upper Airway Anatomy and the Apnea–Hypopnea Index. The Importance of Tongue Fat. American Journal of Respiratory and Critical Care Medicine 201(6) https://doi.org/10.1164/rccm.201903-0692OC
20 Hyde PN, et al. Dietary carbohydrate restriction improves metabolic syndrome independent of weight loss. JCI Insight 4(12):e128308. 2019 https://doi.org/10.1172%2Fjci.insight.128308
21 Unwin DJ, et al. Substantial and Sustained Improvements in Blood Pressure, Weight and Lipid Profiles from a Carbohydrate Restricted Diet: An Observational Study of Insulin Resistant Patients in Primary Care. Int J Environ Res Public Health. 16(15):2680. 2019 https://doi.org/10.3390/ijerph16152680
22 Centre for Perioperative Care. Guideline for Perioperative Care for People with Diabetes Mellitus Undergoing Elective and Emergency Surgery. 2021. https://www.cpoc.org.uk/cpoc-publishes-guideline-perioperative-care-people-diabetes-undergoing-surgery
23 Murdoch C, Unwin D, Cavan D, Cucuzzella M Patel M. Adapting diabetes medication for low carbohydrate management of type 2 diabetes: a practical guide. Br J Gen Pract. 69(684):360–1. 2019 https://bjgp.org/content/69/684/360
24 Freshwell LowCarb Project: Deprescribing for patients with Type 2 Diabetes whose diabetes goes into remission on a Low Carbohydrate Diet. https://lowcarbfreshwell.com/documents/10/Deprescribing-Freshwell-Flow-Chart-v11.pdf
25 Cahill GF. Fuel metabolism in starvation. Annu Rev Nutr 26; 1-22. 2006 https://doi.org/10.1146/annurev.nutr.26.061505.111258
26 Gillis C, et al. Prehabilitation, enhanced recovery after surgery, or both? A narrative review. British Journal of Anaesthesia, 128(3), 434 – 448. 2022. https://www.bjanaesthesia.org/article/S0007-0912(21)00795-9/fulltext
27 Gillis C, Carli F. Promoting Perioperative Metabolic and Nutritional Care. Anesthesiology; 123:1455–1472. 2015 https://doi.org/10.1097/ALN.0000000000000795
28 Noakes T, Volek JS, Phinney SD. Low-carbohydrate diets for athletes: what evidence? British Journal of Sports Medicine 2014;48:1077-1078. https://doi.org/10.1136/bjsports-2014-093824