

## The steatocrit as a measure of fecal fat excretion: uses and pitfalls

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Measurement of fecal fat is an issue that continues to trouble gastroenterologists.<sup>1,2</sup> In the laboratory this may be accomplished by a variety of methods including chemical (chemical titration and gas chromatography), physical (gravimetric methods, near infrared spectrometry), and microscopy.

Fecal fat is composed of triglycerides, diglycerides, monoglycerides and free fatty acids, as well as sterols and phospholipids. The physician dealing with fat malabsorption is concerned with triglycerides and the digestion products of triglycerides (i.e. free fatty acids, monoglycerides, and diglycerides), since the 50–100 g/day of fat that we ingest daily in the diet is almost totally composed of triglycerides.

The classic method used to measure fecal fat quantitatively was the chemical titration method described by van de Kamer.<sup>3</sup> In the van de Kamer method, the feces is first saponified (converted to soaps or potassium salts of fatty acids) by boiling in ethanolic potassium hydroxide. Free fatty acids are released from the soaps by addition of hydrochloric acid, extracted into ether, and titrated against sodium hydroxide to derive total fatty acid content. By converting all forms of long chain fat to free fatty acids, this method quantitatively estimates all fecal fat, and therefore it became and probably continues to remain the gold standard test for steatorrhea in patients with any form of fat malabsorption. The method does not estimate fecal sterols because they cannot be saponified or converted into fatty acid salts. The van de Kamer method estimates fat malabsorption reasonably accurately when the diet

contains mainly long chain triglycerides as is usual for most populations; however, when the diet contains significant amounts of medium chain fat (as in populations using coconut oil as the predominant cooking oil, or in patients with chronic pancreatitis or other conditions causing fat malabsorption receiving medium chain triglycerides as therapy) it underestimates fecal fat. Moreover, the van de Kamer analysis is tedious, involves the collection of stool for several days, and is unpleasant to the both patient and to the technical personnel performing the test. As a result of this, laboratories around the world began to look for alternative simpler methods to measure fecal fat excretion with the result that the van de Kamer titrimetric method for fecal fat is now available in only a few research or reference laboratories around the world.

Visualization of fat globules in the feces using Sudan III or IV stain has been widely used in clinical practice.<sup>4</sup> This method depends on the hydrophobicity of lipid in a water-based solution and the affinity for fat to bind the stain. An aliquot of homogenized stool is placed on a glass slide, acidified with 36% acetic acid, and Sudan III stain added. Five high power fields are examined under the microscope and up to 100 fat droplets 1–4  $\mu\text{m}$  in size are considered normal. Fecal fat is graded as slightly increased or definitely increased depending on the presence of more than 100 droplets in the range 1–5  $\mu\text{m}$  and 6–75  $\mu\text{m}$ , respectively. This is used in most laboratories as a marker for the diagnosis of steatorrhea. A more rigorous counting of the fat droplet size and number, to give a size-number product, is reported to be somewhat more accurate than the method of reporting mentioned above.<sup>5</sup>

Gravimetric methods utilize the physical properties of lipid to partition into different solvents in order to measure fecal fat. Jeejeebhoy *et al.*<sup>6</sup> described a method that involved three extractions from feces with heptane, diethyl ether, and ethanol and finally with water; this was initially introduced because the van de Kamer method did not adequately measure medium chain fats in the stool. The

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Jeejeebhoy method of extraction can be used to measure fats gravimetrically or fatty acids by titration. It measures neutral fat (i.e. triglycerides, either long chain or medium chain) along with fecal sterols, phospholipids and bile acids.<sup>7</sup> The Jeejeebhoy method usually returns a higher fecal fat value than the van de Kamer method particularly when the patient has been ingesting medium chain triglycerides. Near infrared spectroscopy of stool (which does away with the unpleasant process of extraction of fat from stool) also utilizes the physical properties of fat for quantitation and correlates moderately with the van de Kamer and Jeejeebhoy methods.<sup>8</sup> However, the technique requires the use of a fairly expensive instrument and is not much in use anymore.

The steatocrit was introduced in 1981 as a simple method to estimate stool fat in infants.<sup>9</sup> It is akin to the determination of packed cell volume in capillary glass tubes after centrifugation except that in the steatocrit, the stool suspension separates into solid, aqueous and lipid layers. It is the latter layer which is measured in the steatocrit. Acidification of the stool resulted in marked improvement in the performance of the method.<sup>10</sup> This issue of the *Journal* carries an article on the utility of steatocrit and fecal elastase in the diagnostic work up and management of patients with chronic pancreatitis in India.<sup>11</sup> While the steatocrit is a simple test for measuring fecal fat in chronic pancreatitis, the scientific basis behind the use of the test, and its limitations, must be well understood by a generation of gastroenterologists who do not routinely use fecal fat measurements in clinical practice.

The acid steatocrit has been widely used in pediatric clinical practice to assess steatorrhea in pancreatic insufficiency as well as in small intestinal malabsorption.<sup>12–14</sup> However, there have also been reports suggesting that the steatocrit is imprecise and that it is not clinically useful in diagnosing steatorrhea.<sup>15</sup> Some of these differences in its performance may relate to the nature of the steatorrhea. In pancreatic insufficiency with maldigestion of fat, it is largely triglyceride that is excreted in stool. On the other hand in small intestinal mucosal disease, such as tropical sprue, 77% of the excreted fat is in the form of free fatty acids.<sup>16</sup> It is not known to what extent the nature of the fecal fat modifies the steatocrit value and influences the detection of malabsorption. In most studies of steatocrit performance to now, patients with pancreatic insufficiency have comprised the bulk of the patients evaluated for steatorrhea. It is not known whether the steatocrit is more reproducible in pancreatic insufficiency, and whether it underestimates considerably in mucosal disease. Studies containing a large proportion of patients with small bowel mucosal disease may need to be conducted to provide the answer to the above question.

The present study shows that the steatocrit is useful in screening for fat malabsorption in chronic pancreatitis,

uncovering a large proportion of patients with subclinical malabsorption. Screening with steatocrit for subclinical fat malabsorption has been advocated in patients with chronic pancreatitis,<sup>17</sup> and the present study confirms that it is practical to do so. A final word of caution remains in the use of steatocrit in patients with chronic pancreatitis who are regularly ingesting medium chain triglycerides in the diet. Medium chain triglycerides are water soluble and are likely to partition into the water phase rather than the lipid phase in the steatocrit tube, thus underestimating steatorrhea. Until this is adequately characterized, it would be wise to ensure that medium chain triglycerides are withheld, and that long chain triglyceride ingestion is approximately 100 g/day for at least 3 days prior to the performance of the steatocrit.

## References

1. Lust M, Nandurkar S, Gibson PR. Measurement of fecal fat excretion: an evaluation of attitudes and practices of Australian gastroenterologists. *Intern Med J* 2006;36:77–85.
2. Thomas PD, Forbes A, Green J, *et al.* Guidelines for the investigation of chronic diarrhoea. 2nd ed. *Gut* 2003;52(Suppl V):v1–v15.
3. Van de Kamer JH, Huinink HTB, Weyers HA. Rapid method for the determination of fat in feces. *J Biol Chem* 1949;177:347–55.
4. Drummey GD, Benson JA Jr, Jones CM. Microscopical examination of the stool for steatorrhea. *N Engl J Med* 1961;264:85–7.
5. Fine KD, Ogunji F. A new method of quantitative fecal fat microscopy and its correlation with chemically measured fecal fat output. *Am J Clin Pathol* 2000;113:528–34.
6. Jeejeebhoy KN, Ahmad S, Kozak G. Determination of fecal fats containing both medium and long chain triglycerides and fatty acids. *Clin Biochem* 1970;3:157–63.
7. Balasekaran R, Porter JL, Santa Ana CA, Fordtran JS. Positive results on tests for steatorrhea in persons consuming Olestra potato chips. *Ann Intern Med* 2000;132:279–82.
8. Benini L, Caliarì S, Guidi GC, *et al.* Near infrared spectrometry for faecal fat measurement: comparison with conventional gravimetric and titrimetric methods. *Gut* 1989;30:1344–7.
9. Phuapradit P, Narang A, Mendonca P, Harris DA, Baum JD. The steatocrit: a simple method for estimating stool fat content in newborn infants. *Arch Dis Child* 1981;56:725–7.
10. Tran M, Forget P, Van den Neucker A, Strik J, van Kreeel B, Kuijten R. The acid steatocrit: a much improved method. *J Pediatr Gastroenterol Nutr* 1994;19:299–303.
11. Girish BN, Rajesh G, Vaidyanathan K, Balakrishnan V. Fecal elastase-1 and acid steatocrit estimation in chronic pancreatitis. *Indian J Gastroenterol* 2009;28:201–5.
12. Sugai E, Srur G, Vazquez H, *et al.* Steatocrit: a reliable semiquantitative method for detection of steatorrhea. *J Clin Gastroenterol* 1994;19:206–9.
13. Amann ST, Josephson SA, Toskes PP. Acid steatocrit: a simple, rapid gravimetric method to determine steatorrhea. *Am J Gastroenterol* 1997;92:2280–4.

14. Van den Neucker A, Pestel N, Tran TM, *et al.* Clinical use of acid steatocrit. *Acta Paediatr* 1997;86: 466–9.
15. Wagner MH, Bowser EK, Sherman JM, Francisco MP, Theriaque D, Novak DA. Comparison of steatocrit and fat absorption in persons with cystic fibrosis. *J Pediatr Gastroenterol Nutr* 2002;35:202–5.
16. Tiruppathi C, Balasubramanian KA, Hill PG, Mathan VI. Faecal free fatty acids in tropical sprue and their possible role in the production of diarrhoea by inhibition of ATPases. *Gut* 1983;24:300–5.
17. Dumasy V, Delhaye M, Cotton F, Deviere J. Fat malabsorption screening in chronic pancreatitis. *Am J Gastroenterol* 2004;99:1350–4.