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# Metabolic syndrome and visceral obesity as risk factors for reflux oesophagitis: a cross-sectional case–control study of 7078 Koreans undergoing health check-ups

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## ABSTRACT

**Background:** Obesity has been associated with reflux oesophagitis. However, the relationship between metabolic syndrome characterised by visceral obesity and reflux oesophagitis is unclear.

**Aim:** To investigate whether metabolic syndrome or visceral obesity is a risk factor for reflux oesophagitis.

**Methods:** A cross-sectional study of 7078 subjects undergoing upper endoscopy during health check-ups was conducted (3539 patients with reflux oesophagitis vs age- and sex-matched controls). We further analysed according to categories of visceral adipose tissue and subcutaneous adipose tissue area with 750 cases and age-, sex- and waist circumference-matched controls who underwent abdominal CT scan.

**Results:** The prevalence of metabolic syndrome was higher in cases than controls (26.9% vs 18.5%,  $p < 0.001$ ). Multivariate analysis demonstrated that metabolic syndrome is associated with reflux oesophagitis (odds ratio (OR) = 1.42; 95% confidence interval (CI), 1.26 to 1.60). Among the individual components of metabolic syndrome, waist circumference (OR = 1.47; 95% CI, 1.30 to 1.65) and triglyceride (OR = 1.20; 95% CI, 1.05 to 1.36) independently increased the risk for reflux oesophagitis. On sub-analysis, cases showed higher mean visceral adipose tissue area (cm<sup>2</sup>) (136.1 (SD 57.8) vs 124.0 (SD 54.7),  $p < 0.001$ ) and subcutaneous adipose tissue area (cm<sup>2</sup>) (145.9 (SD 56.8) vs 133.5 (SD 50.7),  $p < 0.001$ ). However, only visceral adipose tissue area was an independent risk factor for reflux oesophagitis after adjusting for multiple confounders including smoking, alcohol, body mass index (BMI) and subcutaneous adipose tissue area (OR = 1.60; 95% CI, 1.03 to 2.48, lowest quartile vs highest quartile).

**Conclusions:** Metabolic syndrome was associated with reflux oesophagitis. Abdominal obesity, especially visceral obesity, was an important risk factor for reflux oesophagitis.

Reflux oesophagitis is one of the most common forms of gastro-oesophageal reflux disease (GORD) and the prevalence of erosive oesophagitis in Asia, including Korea, has been increasing dramatically over recent decades.<sup>1–3</sup> Although the reasons for this increase are uncertain, Westernised life-styles, a longer life expectancy and widespread health check-ups may be responsible in Korea. It has been generally accepted that obesity is associated with reflux oesophagitis,<sup>4–12</sup> and abdominal obesity seems to be more important than general obesity as expressed by an elevated body mass index

(BMI).<sup>13–15</sup> To our knowledge, there have been little data demonstrating a positive association between abdominal obesity and GORD.<sup>13–16–17</sup> Although a recently published study using waist circumference as an anthropometric surrogate proposed visceral obesity as a risk factor for reflux oesophagitis,<sup>14</sup> there have been no studies to evaluate the effect of visceral obesity on developing reflux oesophagitis directly by CT scan.

Metabolic syndrome was known as a cluster of metabolic abnormalities consisting essentially of abdominal obesity, especially visceral obesity.<sup>18–19</sup> The syndrome is becoming increasingly common as part an epidemic of obesity and has been highlighted as a risk factor for various gastrointestinal diseases as well as cardiovascular disease.<sup>20–22</sup> However, the relationship between reflux oesophagitis and individual components of metabolic syndrome other than obesity has not been studied extensively.

The aim of this study was to evaluate the association of reflux oesophagitis with metabolic syndrome or individual components of metabolic syndrome, focusing on visceral obesity measured by CT scan.

## METHODS

### Study population

We conducted a cross-sectional case–control study. From October 2004 to April 2007, 48 684 subjects visited the Seoul National University Hospital Healthcare System Gangnam Center for a routine health check-up. Various packages of examinations, including annual upper endoscopy, are available in our centre. Most of the study subjects paid voluntarily for their health check-ups and some of them were supported by their company. About one-fifth of the subjects received abdomen CT scans at their own expense as a part of a routine 3-yearly health plan. Roughly one-third of the subjects kept a check on their health status annually. Their mean age was 48.3 (SD 11.2) years and 52.3% were men. The majority underwent screening upper endoscopy ( $n = 44\ 254$ , 90.9%). Of these, 37 560 subjects were eligible after exclusion of subjects with prior gastric surgery, active or healing staged benign gastric or duodenal ulcer, gastric cancer or current proton pump inhibitor medication. Mostly, they were free of symptoms and some underwent an abdominal CT scan for a routine work-up of the digestive system. The sampling frame for cases consisted of all subjects with endoscopically identified reflux oesophagitis

**Table 1** Comparisons between cases and age- and sex-matched controls with regard to demographic, clinical and metabolic syndrome-related features

	Cases	Controls	p-Value
Age (years)	47.6 (11.1)	47.6 (11.1)	1.000
Male	2810 (79.4%)	2810 (79.4%)	1.000
BMI (kg/m <sup>2</sup> )	24.6 (3.0)	23.9 (2.8)	<0.001
<23	27.6%	36.5%	<0.001
23–24.9	29.1%	29.3%	
≥25	43.3%	34.1%	
Waist circumference (cm)	88.0 (8.1)	85.8 (7.7)	<0.001
Systolic blood pressure (mm Hg)	120.0 (15.5)	118.9 (15.3)	0.004
Diastolic blood pressure (mm Hg)	78.9 (11.8)	78.3 (11.5)	0.020
Fasting glucose (mg/dl)	103.0 (23.5)	100.7 (19.7)	0.001
Total cholesterol (mg/dl)	195.7 (34.4)	194.4 (33.3)	0.091
Triglyceride (mg/dl)	139.7 (93.5)	121.4 (73.6)	<0.001
High-density lipoprotein cholesterol (mg/dl)	51.1 (12.7)	52.0 (12.4)	0.002
Current smoking	1129 (31.9%)	835 (23.6%)	<0.001
Alcohol consumption	870 (24.6%)	625 (17.7%)	<0.001

Results are given as mean (SD), except where indicated otherwise, and n = 3539 for both cases and controls. BMI, body mass index.

who never sought medical advice. To modify the confounding effects, controls were selected randomly from the persons matched for age and sex among the entire subjects with normal upper endoscopic findings and without any reflux symptoms. A total of 7078 subjects, including 3539 cases, were finally enrolled in this study.

### Definitions

The reflux oesophagitis was defined if definite erosions (mucosal breaks) or minimal mucosal changes (erythema and/or whitish discoloration) were present. The severity of reflux oesophagitis was graded from M to D according to the Los Angeles (LA) classification system with Japanese modifications.<sup>23</sup> Subjects were labelled as having metabolic syndrome by the presence of three or more of the following Regional Office for the Western Pacific Region of World Health Organization (WPRO) waist circumference criteria<sup>24</sup> of the National Cholesterol Education Program Adult Treatment Panel III: (1) abdominal obesity (waist circumference >90 cm in men and

>80 cm in women); (2) blood pressure ≥130/85 mm Hg; (3) fasting glucose ≥110 mg/dl; (4) triglyceride ≥150 mg/dl; (5) high-density lipoprotein cholesterol <40 mg/dl in men and <50 mg/dl in women.

### Exposure measurements

All subjects underwent physical examinations by trained personnel who used a written, systematic protocol with standardised instruments. BMI was calculated from measured weight and height and according to the modified WHO criteria from the Asia-Pacific guideline,<sup>24</sup> categorised as follows: normal (<23 kg/m<sup>2</sup>), overweight (23–24.9 kg/m<sup>2</sup>) and obese (≥25 kg/m<sup>2</sup>). The measurements of waist circumference were made at the WHO recommended site; midpoint between the lower border of rib cage and iliac crest.<sup>25</sup> We also measured blood pressure and blood markers such as fasting glucose, triglyceride and high-density lipoprotein cholesterol. Structured questionnaires were reviewed on reflux symptoms and the confounding variables related to reflux oesophagitis including current smoking (smoked regularly during the previous 12 months) and alcohol consumption (≥140 g/week or ≥20 g/day).

### Measurement of abdominal adipose tissue areas by computed tomography scan

The technique used for adipose tissue area measurements in CT cross-sectional images has been previously standardised and validated,<sup>26–28</sup> and has only negligible inter-observer variation.<sup>29–30</sup> The subjects were examined with a 16-detector row CT scanner (Somatom Sensation 16; Siemens Medical Solutions, Forchheim, Germany) in a supine position. A single slice at the level of umbilicus measuring 5 mm in thickness was obtained at 120 kV<sub>p</sub> and 260 mA with a scan time of 0.5 s. Cross-sectional surface area (in cm<sup>2</sup>) of different abdominal fat compartments was calculated at this slice using a commercially available CT software (Rapidia 2.8; INFINITT, Seoul, Korea), which determined adipose tissue area electronically by setting the attenuation values for a region of interest within a range of –250 to –50 Hounsfield units. Visceral adipose tissue area was defined as intra-abdominal fat bound by parietal peritoneum or transversalis fascia, excluding vertebral column and paraspinal muscles. Subcutaneous adipose tissue area was defined as fat superficial to abdominal and back muscles. Using a manual tracing method with a cursor, the area of visceral adipose tissue was measured around the inner boundary of the abdominal wall

**Table 2** Univariate and multivariate analyses on the risk for reflux oesophagitis by smoking, alcohol, body mass index (BMI) and metabolic syndrome (after matching for age and sex)

	Cases (%) (n = 3539)	Controls (%) (n = 3539)	Univariate analysis		Multivariate analysis*	
			OR (95% CI)	p Value	OR (95% CI)	p Value
Current smoking						
Yes	31.9	23.6	1.52 (1.37 to 1.69)	<0.001	1.42 (1.27 to 1.58)	<0.001
Alcohol consumption						
Yes	24.6	17.7	1.52 (1.35 to 1.71)	<0.001	1.41 (1.25 to 1.58)	<0.001
BMI (kg/m <sup>2</sup> )						
≥25	43.3	34.1	1.48 (1.34 to 1.62)	<0.001	1.13 (0.92 to 1.29)	0.056
Metabolic syndrome						
Yes	26.9	18.5	1.62 (1.45 to 1.81)	<0.001	1.42 (1.26 to 1.60)	<0.001

\*Adjusted for smoking, alcohol, BMI and metabolic syndrome. BMI, body mass index; CI, confidence interval; OR, odds ratio.

**Table 3** Risk across the severity of reflux oesophagitis in relation to the presence of metabolic syndrome

	Control (n = 3539)	LA-M (n = 1219)	LA-A or LA-B (n = 2258)	LA-C or LA-D (n = 62)
Metabolic syndrome (%)	18.5	22.8	28.9	33.9
OR (95% CI)*	1	1.30 (1.11 to 1.52)	1.79 (1.58 to 2.03)	2.26 (1.32 to 3.84)

\*Adjusted for smoking, alcohol and BMI.

CI, confidence interval; BMI, body mass index; LA, Los Angeles classification; OR, odds ratio.

muscles; the boundaries for non-adipose tissues within the visceral region; ie, bone, muscle, organs, blood vessels and bowels were traced out, and these regions were excluded from the calculation of the visceral adipose tissue area. A region of interest drawn around the external margin of dermis was used to calculate the area of the total adipose tissue. The subcutaneous adipose tissue area was obtained by subtracting visceral adipose tissue area from total adipose tissue area. Given the lack of data regarding an appropriate "healthy" abdominal adipose tissue area for preventing metabolic syndrome and high prevalence of overweight or obesity in our population, with an almost total absence of underweight (0.5%), as well as gender difference in abdominal fat composition, before analysis we selected the sex-specific lowest quartile of visceral adipose tissue and subcutaneous adipose tissue area as reference groups.

### Statistical analysis

The continuous variables measured in this study were expressed as mean, with the standard deviation (SD). In between-group comparisons, continuous variables were analysed by the Student *t* test and categorical variables by the  $\chi^2$  test. In the multivariate logistic regression models we included additional variables with a known or probable association with reflux oesophagitis, such as smoking, alcohol and BMI.<sup>8</sup> Analyses were performed using the Statistical Package for the Social Sciences (version 12.0; SPSS, Chicago, IL, USA). For each variable, the odds ratio (OR) and 95% confidence interval (95% CI) were given. A two tailed *p*-value of <0.05 was considered statistically significant. Age and sex matching and statistical analysis were supported by the Seoul National University Hospital Medical Research Collaborating Center.

## RESULTS

### Clinical characteristics

Reflux oesophagitis was found in 3539 (9.4%) of the 37 560 subjects who met the initial inclusion criteria: 1219 (34.4%) in LA-M, 1657 (46.8%) in LA-A, 601 (17.0%) in LA-B, 55 (1.6%) in LA-C and 7 (0.2%) in LA-D. The characteristics of the study population are presented in table 1. The mean age was 47.6 (SD 11.1) years and 79.4% were men. The prevalence of metabolic syndrome was higher in subjects with reflux oesophagitis than in controls (26.9% vs 18.5%, *p*<0.001). Cases had higher mean BMI than controls. In addition, there were significant associations of reflux oesophagitis with smoking, alcohol and individual components of metabolic syndrome. We performed a separate analysis on the subjects with LA-M, the less severe form, in whom it would be likely that the diagnosis of reflux oesophagitis might be in question and did not find any different results; BMI (24.8 (SD 3.0), *p*<0.001) and the proportion of metabolic syndrome (26.6%, *p*<0.001) were significantly higher in subjects with LA-M than in the controls (data not shown).

### Metabolic syndrome and reflux oesophagitis

The univariate and multivariate analyses on the risk for reflux oesophagitis among the confounding variables including smoking, alcohol, BMI and presence of metabolic syndrome were shown in table 2. On the multivariate analysis, smoking, alcohol and metabolic syndrome were associated with an increased risk for reflux oesophagitis; however, the effect of BMI on reflux oesophagitis was no longer statistically significant.

The analyses conducted according to the severity of reflux oesophagitis are shown in table 3. Positive associations with metabolic syndrome were observed across all grades of reflux oesophagitis including LA-M.

**Table 4** Risk of the individual components of metabolic syndrome for reflux oesophagitis (after matching for age and sex)

	Cases (%)	Controls (%)	Univariate analysis		Multivariate analysis*		Multivariate analysis†	
	(n = 3539)	(n = 3539)	OR (95% CI)	p Value	OR (95% CI)	p Value	OR (95% CI)	p Value
Increased waist circumference‡								
(+)	48.4	37.0	1.60 (1.45 to 1.76)	<0.001	1.51 (1.35 to 1.69)	<0.001	1.47 (1.30 to 1.65)	<0.001
Elevated blood pressure								
(+)	45.2	40.1	1.31 (1.16 to 1.48)	<0.001	1.14 (1.04 to 1.26)	0.007	1.10 (0.98 to 1.22)	0.101
Raised fasting glucose								
(+)	20.9	17.7	1.23 (1.09 to 1.38)	0.001	1.13 (1.00 to 1.28)	0.042	1.06 (0.92 to 1.21)	0.443
Hyper-triglyceride								
(+)	31.9	24.0	1.48 (1.34 to 1.65)	<0.001	1.27 (1.14 to 1.42)	<0.001	1.20 (1.05 to 1.36)	0.006
Low high-density lipoprotein cholesterol								
(+)	25.3	20.9	1.28 (1.14 to 1.43)	<0.001	1.24 (1.11 to 1.39)	<0.001	1.14 (0.99 to 1.29)	0.057

\*Adjusted for smoking, alcohol and body mass index (BMI).

†Adjusted for smoking, alcohol, BMI and individual components of metabolic syndrome.

‡ &gt;90 cm in men and &gt;80 cm in women.

CI, confidence interval; OR, odds ratio.

When the individual components of metabolic syndrome were analysed separately, only increased waist circumference and elevated triglyceride were significantly associated with reflux oesophagitis after adjusting for smoking, alcohol, BMI and other components of metabolic syndrome (OR = 1.47; 95% CI, 1.30 to 1.65,  $p < 0.001$ ; and OR = 1.20; 95% CI, 1.05 to 1.36,  $p = 0.006$ ) (table 4).

### Visceral obesity and reflux oesophagitis

To explore the role of visceral adipose tissue and subcutaneous adipose tissue area as possibly being in the causal pathway between waist circumference and reflux oesophagitis, we further analysed the risk for reflux oesophagitis according to the categories of visceral adipose tissue and subcutaneous adipose tissue area with 750 cases and controls matched for age, sex and waist circumference who underwent screening abdominal CT scan (table 5). Importantly, there were minor and no significant differences in clinical characteristics between cases with and without CT scan, as well as between controls with and without CT scan (data not shown). The overall amount of visceral adipose tissue and subcutaneous adipose tissue area were 130.07 (SD 56.6)  $\text{cm}^2$  and 139.70 (SD 54.2)  $\text{cm}^2$ , respectively. Cases showed higher mean visceral adipose tissue and subcutaneous adipose tissue area. In univariate analysis, all categories of visceral adipose tissue area and the highest quartile of subcutaneous adipose tissue area were significantly associated with reflux oesophagitis. However, only visceral adipose tissue area remained as an independent risk factor for reflux oesophagitis after adjusting multiple confounding variables including smoking, alcohol, BMI and subcutaneous adipose tissue area (OR = 1.60; 95% CI, 1.03 to 2.48,  $p = 0.035$ , lowest quartile vs highest quartile of visceral adipose tissue area); furthermore, a dose-dependent relationship continued across all categories of visceral adipose tissue area ( $p$  for trend  $< 0.05$  for all quartiles, data not shown). Sex-specific multivariate models were also constructed and the association between visceral adipose tissue area and reflux oesophagitis did not differ between the both sexes (data not shown).

### DISCUSSION

To the best of our knowledge, this is the first report establishing a positive association between metabolic syndrome and reflux oesophagitis. Among the individual components of metabolic syndrome, abdominal obesity and elevated triglyceride independently increased the risk for reflux oesophagitis. Additionally, the present study demonstrates for the first time that only visceral adipose tissue area calculated by cross-sectional CT images was an independent risk factor for reflux oesophagitis after controlling for smoking, alcohol, BMI and subcutaneous adipose tissue area.

Abdominal obesity may aggravate gastro-oesophageal reflux with several plausible mechanisms. A commonly suggested pathogenesis is through the direct mechanical effect of abdominal fat volume on increasing gastric pressure and resultant frequent lower oesophageal sphincter relaxation with acid reflux.<sup>15 31–35</sup> However, this is unlikely to be the principal mechanism, since obesity only causes a moderate increase in abdominal pressure and which alone does not lead to reflux in experimental models.<sup>33 36–38</sup> Considering that, in our study, it was not the subcutaneous adipose tissue area but only the visceral adipose tissue area that increased the risk for reflux oesophagitis, another potential mechanism may relate specifically to the visceral component of abdominal fat. Visceral adipose tissue is recognised to be metabolically active and has been strongly associated with elevated serum levels of pro-inflammatory adipokines including interleukin 6, tumour necrosis factor- $\alpha$  and adiponectin which may play a role in the development of GORD.<sup>22 34</sup> Visceral adipose tissue is also a precursor to increased lipolysis and free fatty acid leading to insulin resistance, which is regarded as a primary factor in the mechanisms of metabolic syndrome.<sup>18 19 39 40</sup> Our data also showed that among the individual components of metabolic syndrome, elevated triglyceride level was an independent predictor for reflux oesophagitis. It is possible that such humoral compounds might alter the lower oesophageal sphincter pressure or affect oesophageal clearance of refluxate, although minimal data exist.

**Table 5** Risk of the abdominal adipose tissue areas measured by computed tomography scan for reflux oesophagitis (after matching for age, sex and waist circumference)

	Cases (%)	Controls (%)	Univariate analysis		Multivariate analysis*	
	(n = 750)	(n = 750)	OR (95% CI)	p Value	OR (95% CI)	p Value
<b>Visceral adipose tissue area (<math>\text{cm}^2</math>)</b>						
Mean (SD)	136.1 (57.8)	124.0 (54.7)				
Quartile I (M <104.6, F <52.1)	20.3	29.9	1.00		1.00	
Quartile II (M 104.6–136.5, F 52.1–79.5)	25.6	24.4	1.55 (1.16 to 2.06)	0.003	1.47 (1.06 to 2.06)	0.023
Quartile III (M 136.6–170.0, F 79.6–111.0)	26.1	23.5	1.64 (1.23 to 2.19)	0.001	1.52 (1.04 to 2.22)	0.032
Quartile IV (M >170.0, F >111.0)	28.0	22.3	1.85 (1.39 to 2.48)	<0.001	1.60 (1.03 to 2.48)	0.035
<b>Subcutaneous adipose tissue area (<math>\text{cm}^2</math>)</b>						
Mean (SD)	145.9 (56.8)	133.5 (50.7)				
Quartile I (M <100.6, F <120.1)	21.3	28.5	1.00		1.00	
Quartile II (M 100.6–129.5, F 120.1–159.5)	25.7	24.4	1.27 (0.95 to 1.68)	0.104	1.13 (0.81 to 1.57)	0.468
Quartile III (M 129.6–161.0, F 159.6–203.0)	24.7	25.2	1.32 (0.99 to 1.75)	0.062	0.99 (0.68 to 1.43)	0.952
Quartile IV (M >161.0, F >203.0)	28.3	21.9	2.02 (1.50 to 2.72)	<0.001	1.21 (0.80 to 1.84)	0.376

\*Adjusted for smoking, alcohol, BMI, visceral adipose tissue area and subcutaneous adipose tissue area. BMI, body mass index; M, males; F, females.

Reflux oesophagitis is known to be less prevalent in Asian countries and Asians appear to have a milder spectrum of disease (mostly grade A or B) with less erosive oesophagitis.<sup>6 41–43</sup> Moreover, studies from the Far East reported that minimal change oesophagitis below grade A constitutes a great part of GORD and similar findings have been published from Europe.<sup>23 44–46</sup> However, most of the current series regarding the prevalence of GORD used the LA classification based on the extent of apparent mucosal breaks and excluded the grade M which denotes non-erosive minimal mucosal changes. This has been thought to underestimate the prevalence of reflux oesophagitis especially in Asians.<sup>44 45</sup> The present study included minimal changes as a part of reflux oesophagitis in order to increase the sensitivity of endoscopy in the diagnosis of GORD;<sup>47</sup> a positive association extended between metabolic syndrome and across all categories of oesophagitis including grade M. We used a modified BMI criteria as proposed by WPRO,<sup>24</sup> which allows for the smaller body frame of Asians and gives a more accurate reflection of body fat stores, thus avoiding a false perception of “not overweight”.

A major advantage of our study is the use of a CT scan, which has high degree of validity and reproducibility to estimate abdominal adipose tissue area. Furthermore, an abdominal CT scan and upper endoscopy were performed on the same day as a health check-up programme, which allowed the accurate assessment of implications between visceral obesity and reflux oesophagitis. Second, the data collected were of high quality; the measurements were obtained by trained personnel with a systematic protocol, not self-reported measurements. Third, the sample size is extremely large, which allowed well-powered evaluations of subpopulations and analysis of interactions. Lastly, and most importantly, based on a screening policy, the subjects in this study are generally regarded to be representative of general population. Therefore, a selection bias was less likely given the same indications for endoscopy and abdominal CT scan between cases and controls.

This study had several limitations. First, the cross-sectional design makes it difficult to be emphatic about temporal association between metabolic syndrome or visceral obesity and development of reflux oesophagitis.

Second, we did not evaluate the effect of diet which has been suggested as a possible mechanism for an increased risk of GORD in obesity. However, recent studies reported that no relationship was found between the higher fat intake and risk of GORD or its hospitalisation.<sup>5 9</sup> Therefore, it is unlikely that dietary fat intake is a pivotal explanation for the effect of obesity on GORD.

Third, we did not check  $\kappa$  values for evaluating inter-observer variations in endoscopic diagnosis. However, all investigators in this study had finished gastroenterology fellowships in university hospitals and were experts in endoscopy.<sup>47</sup> In addition, humoral factors such as insulin, leptin or adipokines by which visceral adipose tissue contributes to the development of reflux oesophagitis were not examined.

Finally, medium-to-high socioeconomic status of our study subjects also might lead to selection bias. However, socioeconomic status has not been established as a major determinant for the risk of GORD.<sup>48</sup>

In conclusion, our study suggests that abdominal obesity may be the main component of metabolic syndrome cluster driving association between metabolic syndrome and reflux oesophagitis risk. This seems to be largely mediated through visceral obesity. Although there has been a debate whether weight loss improves GORD symptoms or oesophagitis in overweight

persons,<sup>49–51</sup> the accurate interpretation of our data is that avoiding weight gain and the accompanying metabolic syndrome in the first place is associated with a lower risk of GORD. Further studies are required to clarify the underlying mechanism and causal relationship between visceral adipose tissue and reflux oesophagitis.

**Competing interests:** None.

**Ethics approval:** The study protocol was approved by the Institutional Review Board of the Seoul National University Hospital and was carried out according to the guidelines of the Declaration of Helsinki.

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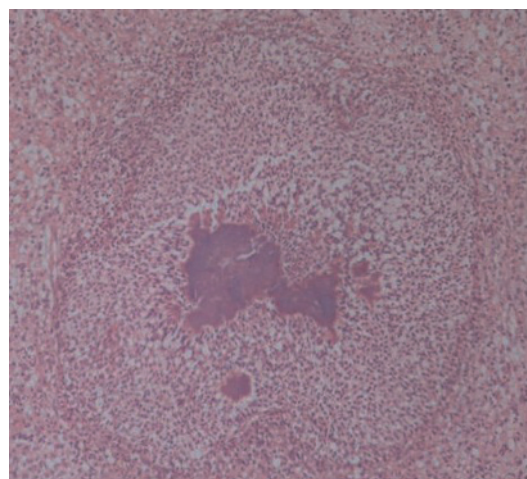
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## Editor's quiz: GI snapshot

### ANSWER

From the question on page 1344

The differential diagnosis of a lower right quadrant mass includes Crohn's disease, tuberculosis and neoplasia; and, less commonly, psoas abscess, pelvic kidney, ovarian cyst and mucocele of the gallbladder. The computed tomography scan (fig 1 in the question) shows right iliac fossa mass involving the terminal ileum, caecum, ascending colon and right ovary. Laparotomy was performed. Macroscopic examination revealed a strictured segment in the terminal ileum with a mass in the caecum with thickened bowel wall, abscess formation and localised perforation. The appendix was unremarkable. Pathological examination revealed extensive transmural inflammation, fibrosis and focal dark bacterial colonies (fig 1 below) consistent with actinomycosis. Actinomycete is a filamentous, Gram-positive anaerobic bacterium causing a chronic indolent ileo-caecal infection characterised by suppurative granulomatous inflammation, formation of multiple abscesses with sinus tracts that may discharge so-called "sulfur granules". Actinomycosis is rare but has a predilection for cervicofacial and ileocaecal regions. Pelvic actinomycosis has also been associated with an intra-uterine contraceptive device. It is unusual to diagnose ileo-colonic actinomycosis prior to



**Figure 1** Section from the ileocaecal region. Haematoxylin & eosin,  $\times 400$ .

laparotomy. Medical treatment is with prolonged antibiotic treatment with penicillin.

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