



ARTIGO ORIGINAL

Visceral fat: A key factor in diverticular disease of the colon

Miguel Afonso,* Joana Pinto, Ricardo Veloso, Teresa Freitas, João Carvalho, José Fraga

Serviço de Gastreenterologia, Centro Hospitalar de Vila Nova de Gaia/Espinho, Vila Nova de Gaia/Espinho, Portugal

Received April 11, 2011; accepted July 7, 2011

KEYWORDS

Obesity;
Visceral fat;
Abdominal
ultrasonography;
Diverticular disease

Abstract

Background and aim: Diverticular disease of the colon is a common disease, representing an important health problem in Western countries. The authors aimed to study the visceral fat and parameters of obesity in the diverticular disease of the colon.

Methods: Case-control study of unselected medium-risk subjects who underwent colonoscopy for screening of colorectal cancer during 1 year. Subjects were inquired by a nutritionist about nutritional habits. Anthropometric variables were evaluated. Visceral and subcutaneous fat were assessed by ultrasound by the same gastroenterologist. Statistics: χ^2 , *t* test, logistic multivariate regression, odds ratio (OR).

Results: Included 303 individuals, 46.9% female, mean age 60 ± 6.6 years. Sixty-four (21%) individual had diverticular disease of the colon. People with diverticula were significantly older ($P=0.01$), had more visceral fat ($P<0.01$), waist circumference ($P=0.01$) and total fat consumption ($P=0.01$). Logistic regression analysis showed age and visceral fat as independent risk factors for diverticular disease of the colon. The probability of occurrence of disease was 3-times higher in individuals in the 3rd tertile of age (older than 63 years old) than those younger than 56 years old (1st tertile of age) – OR 3.1, 95% CI 1.5-6.5. For visceral fat, those individuals in the 3rd tertile had a two-fold risk of having diverticular disease of the colon (OR 2.3, 95% CI 1.02-5.2) than those in 1st tertile. There was no significant difference for sex, body mass index, subcutaneous fat or fiber intake.

Conclusion: Older age and higher visceral fat were independent risk factors for the occurrence of diverticular disease of the colon.

© 2011 Published by Elsevier España, S.L. on behalf of Sociedade Portuguesa de Gastreenterologia. All rights reserved.

*Corresponding author.

Email address: miguelalvesafonso@gmail.com (M. Afonso).

Artigo relacionado com: Fibra, obesidade e doença diverticular – mudança de paradigma

PALAVRAS-CHAVE

Obesidade;
Gordura visceral;
Ecografia abdominal;
Doença diverticular
do cólon

Obesidade visceral: factor de risco para doença diverticular do cólon**Resumo**

Introdução e objetivos: A doença diverticular do cólon é uma doença comum, representando um importante problema de saúde nos países ocidentais. Os autores pretenderam estudar a relação da gordura visceral e outros parâmetros de obesidade na doença diverticular do cólon. *Métodos:* Estudo de indivíduos não seleccionados, de médio risco que efectuaram colonoscopia para rastreio de cancro colorectal, durante um ano. Os indivíduos responderam a inquérito nutricional por nutricionista. Foram avaliadas variáveis antropométricas. A gordura visceral e subcutânea foram avaliadas através de ecografia abdominal efectuada pelo mesmo gastroenterologista. Análise estatística: χ^2 , teste *t*, regressão logística multivariada, odds ratio (OR).

Resultados: Incluídos 303 indivíduos, 46,9% eram do sexo feminino, idade média $60 \pm 6,6$ anos. Sessenta e quatro (21%) apresentavam doença diverticular do cólon. Os indivíduos com diverticulose eram mais idosos ($p = 0,01$), tinham mais gordura visceral ($p < 0,01$), maior perímetro de cinta ($p = 0,01$) e consumo de gordura ($p = 0,01$). A idade e a gordura visceral foram factores de risco independentes para doença diverticular do cólon. A presença de diverticulose cólica foi 3 vezes maior nos indivíduos no 3.º tercil de idade (> 63 anos) do que naqueles com menos de 56 anos (1.º tercil) – OR = 3,1, IC 95% 1,5-6,5. Relativamente à gordura visceral, os indivíduos no 3.º tercil tiveram um risco duas vezes maior (OR 2,3, IC 95% 1,02-5,2) do que aqueles no 1.º tercil. Não houve diferença significativa quanto ao sexo, índice de massa corporal, gordura subcutânea ou consumo de fibra.

Conclusão: A idade e a gordura visceral foram factores de risco independentes para a ocorrência de doença diverticular do cólon.

© 2011 Publicado por Elsevier España, S.L. em nome da Sociedade Portuguesa de Gastrenterologia. Todos os direitos reservados.

Introduction

Diverticular disease of the colon (DDC) is common in Western countries, with a prevalence of up to 50% in the elderly, affecting generally the left colon.¹⁻³ In 80% of individuals the disease remains asymptomatic, but the remaining can develop complications of DDC as diverticulitis with perforation, obstruction or abscesses formation; and acute diverticular bleeding (3-15% of patients).^{4,5} One estimate puts European DDC associated mortality at 23 600 deaths annually.⁶

Age is a major risk factor for DDC. Some observational studies found that lower intake of dietary fiber correlates with higher prevalence of DDC. However, some argue that dietary fiber consumption may be inversely related to total energy consumption and hence adiposity.⁷ Some studies showed that BMI,⁸ waist circumference,⁹ and waist-to-hip ratio⁹ significantly increased the risks of complicated DDC, but there appears to be no published data on the relationship between obesity and asymptomatic DDC.

The authors aimed to study visceral fat (VF) and parameters of obesity in the diverticular disease of the colon as well as the dietary consumption of fat in DDC.

Materials and methods

In total, 303 unselected caucasian subjects underwent colonoscopy for colorectal cancer screening (reaching at least proximal sigmoid colon) at the Gastroenterology Department, between April 2009 and March 2010.

Subjects were inquired by a nutritionist about nutritional habits using a validated questionnaire. The same nutritionist evaluated anthropometric variables (BMI, waist and hip circumference).

Visceral fat (VF) and subcutaneous fat (SF) were assessed by ultrasound by the same gastroenterologist.

Both investigators were blind for colonoscopic findings.

Data collection

We collected data on age and gender.

A standard questionnaire was carried out by a nutritionist. Total caloric intake, fat and dietary fiber consumption were evaluated.

Anthropometric data

In this study, all participants had their anthropometric data taken in the same day. BMI was calculated as weight divided by height squared. Waist circumference was measured at the midpoint between the lateral iliac crest and lowest rib; hip circumference, at the level of the trochanter major.

Obesity was defined as BMI >30 kg/m² using World Health Organization criteria as BMI ≥ 30 kg/m².

Visceral and subcutaneous fat

Visceral and subcutaneous fat were assessed by abdominal ultrasound (Pro Focus® BK Medical, Herlem, Denmark) using a 3.5-MHz probe located 1 cm above the umbilicus.

The subcutaneous fat thickness was defined as the distance between the skin and the external face of the rectus abdominis muscle. The visceral fat thickness was defined as the distance between the internal face of rectus abdominis muscle and the anterior wall of the aorta.

Colonoscopy

Colonoscopy was performed after using polyethylene glycol-containing lavage solution for colon preparation by use of electronic video endoscopes (Model Exera CF-Q 145/160, Olympus Optical Co, Hamburg, Germany).

All participants gave their informed consent.

Statistical analysis

The data were evaluated using descriptive statistical methods (mean \pm SD, ranges). For correlation analysis we used Pearson Correlation. Unpaired Students's *t*-test was used to compare means. Frequency distribution was calculated by the χ^2 test or Fisher's exact probability test. Level of significance was set at $P < 0.05$. Various risk factors were also evaluated using multivariate regression analysis. Bivariate analysis was carried out, using the odds ratio (OR) to test for associations between age, visceral fat and the presence of diverticular disease of colon. An OR with a 95% confidence interval that did not include the value of 1.00 in its range was considered statistically significant. Statistical calculations were performed using SPSS Version 17.0 for Windows (SPSS Inc Chicago, USA).

Results

Of the 303 subjects, sixty-four (21%) had diverticular disease of the colon. One hundred and forty two (46.9%) were female and the mean age was 60 ± 6.6 years.

Obesity and distribution of fat

Mean BMI was 27.7 kg/m^2 , with a prevalence of obesity of 25%. Other anthropometric parameters are discriminated in Table 1.

Visceral fat had the strongest correlation with waist circumference ($r=0.6$ $P < 0.01$) but correlated as well with BMI ($r=0.43$ $P < 0.01$) and hip circumference ($r=0.39$ $P < 0.01$).

There was significant difference for BMI between men and women ($P < 0.01$). Men had significantly more visceral fat but

Table 1 Obesity parameters in studied population

	Mean	SD
Age (years)	60	6.6
BMI (kg/m^2)	27.7	3.8
Waist circumference (cm)	96.5	9.1
Hip circumference (cm)	102.2	7.6
Waist-to-hip ratio	0.94	0.06
Visceral fat (mm)	41.7	18.3
Subcutaneous fat (mm)	15.6	5.2

BMI, body mass index; SD, standard deviation.

lesser subcutaneous fat ($P < 0.01$). Waist circumference was higher in men ($P=0.07$) but hip circumference was higher in women ($P < 0.05$). Waist-to-hip ratio was lower in the female ($P < 0.05$).

Risk factors of diverticular disease of the colon

The characteristics of the patients with or without DDC are listed in Table 2.

In the univariate analysis, there was a significant difference between groups for age ($P=0.01$), visceral fat ($P < 0.01$), waist circumference ($P=0.01$), waist-to-hip ratio ($P=0.04$) and total fat consumption ($P=0.01$). There was no significant difference for gender, BMI, subcutaneous fat, hip circumference or fiber intake.

Individuals in the third tertile of age (≥ 63 years) showed 3-times increased risk of DDC (OR 3.1; 95%CI 1.4-6.4) compared to those in the first tertile (< 56 years).

After adjustment for age, visceral fat confirmed to be a risk factor for diverticular disease ($P < 0.01$).

Subjects in the third tertile of visceral fat (≥ 46.9 mm) demonstrated a more than 2-fold increase in risk of DDC (OR 2.3; 95%CI 1.02-5.2) compared to those in the first tertile (< 32.7 mm).

Discussion

The study confirmed older age as a risk factor of diverticular disease as demonstrated in previous studies.¹⁻³ In the present study, subjects older than 63 years old had a 3-times increased risk of DDC compared to those younger than 56 years old.

Several previous studies evaluated the association between obesity and DDC or its complications.

A prospective cohort study of 47 228 male health professionals showed that waist circumference, and waist-to-hip ratio significantly increased the risks of diverticulitis and diverticular bleeding.⁹

Rosemar *et al.* followed a cohort of 7494 men for a period of 28 years.⁸ One hundred and twelve patients were

Table 2 Clinical variables in subjects with and without diverticular disease of the colon: univariate analysis

	DDC	Ø DDC	P value
Age (years)	62.5 \pm 6.2	59.3 \pm 6.5	0.01
BMI (kg/m^2)	28.1 \pm 3.5	27.6 \pm 3.9	0.4 (NS)
Waist circumference (cm)	99.6 \pm 8.4	95.5 \pm 9.2	0.01
Hip circumference	103.6 \pm 8.0	101.8 \pm 7.5	0.16 (NS)
Waist-to-hip ratio	0.96 \pm 0.06	0.93 \pm 0.06	0.04
Visceral fat (mm)	49.2 \pm 20.4	39.8 \pm 17.2	< 0.01
Subcutaneous fat (mm)	15.5 \pm 4.3	15.7 \pm 5.5	0.8 (NS)
Caloric intake (cal)	2543 \pm 538	2311 \pm 659	0.1 (NS)
Total fat intake (g)	89.2 \pm 29.8	74.9 \pm 23.2	0.01
Fiber intake (g)	27.5 \pm 8.3	25.7 \pm 8.9	0.4 (NS)

BMI, body mass index; DDC, diverticular disease of the colon; NS, non significant.

hospitalized because of complicated diverticular disease of the colon. In those patients, BMI was an independent risk factor.

A retrospective study by *Dobbins et al.* found that patients with perforations and recurrent diverticulitis were significantly more obese.¹⁰

Several studies consistently shown a correlation between visceral fat and chronic subclinical inflammation as visceral fat produces elevated serum levels of several pro-inflammatory cytokines.¹¹⁻¹⁴ Narayan and Floch¹⁵ noticed more frequent microscopic non-specific inflammation from normal mucosa at endoscopy in DDC cases than in controls. Inflammation may play an important role in the pathogenesis of diverticular disease and its complications.

Physiologic studies in left colon diverticular disease have shown a diminution of action of non-adrenergic non-cholinergic inhibitory nerves by substances such as nitric oxide, inducing high intraluminal pressure by colonic segmentation.¹⁶ The same results have been reproduced in right side colon diverticular disease.¹⁷ As it is established that visceral fat induces nitric oxide synthase,¹⁴ it may be the mechanism that links visceral fat to diverticula formation.

In the present study, visceral adiposity was a risk factor for DDC occurrence. Total fat intake also significantly associated with the presence of DDC.

As observed in other diseases of the gastrointestinal tract,¹⁴ visceral obesity associated to high fat intake may be an important risk factor for development of DDC (and possibly of complicated DDC). This relationship should be further evaluated, in the future, in a larger cohort study as this study was designed to evaluate specifically the role of visceral fat in DDC.

The protective role of fiber on DDC pathogenesis has been well studied. However, some authors advocate that this could be biased as high fiber diets are associated with decreased fat consumption.⁷ The authors didn't find a significant association between fiber consumption and DDC only in the univariate analysis. Larger population based studies will be need to confirm the role of fiber in DDC development.

A major advantage of this study was to evaluate visceral fat by abdominal ultrasound. The evaluation of visceral fat by computed tomography carries concerns about radiation exposure and cost. Several previous studies have confirmed abdominal ultrasound as a safe, inexpensive, reproducible and accurate method of evaluating visceral fat.^{18,19} The authors conducted previously studies that validated the technique. This is a major advantage for conducting larger population-based studies.

We observed some limitations in this study. First, we included only patients between the ages of 50 and 76 years old. Second, it would be important to follow this cohort of patients in order to report the incidence of complicated diverticular disease.

In summary, in this study the authors found that visceral fat was an independent factor for the occurrence of diverticular disease, but further studies are needed to confirm these

results in order to understand the importance of diet and fat distribution in the pathogenesis of diverticular disease and its complications.

Conflicts of interest

The authors have no conflicts of interest to declare.

References

1. Painter NS, Burkitt DP. Diverticular disease of the colon, a 20th century problem. *Clin Gastroenterol.* 1975;4:3-22.
2. Schoetz DJ. Diverticular disease of the colon: a century-old problem. *Dis Colon Rectum.* 1999;42:703-9.
3. Parks TG. Natural history of diverticular disease of the colon. *Clin Gastroenterol.* 1975;4:53-69.
4. Jacobs DO. Diverticulitis. *N Engl J Med.* 2007;357:2057-66.
5. Jensen DM, Machicado GA, Jutabha R, et al. Urgent colonoscopy for the diagnosis and treatment of severe diverticular hemorrhage. *N Engl J Med.* 2000;342:78-82.
6. Delvaux M. Diverticular disease of the colon in Europe: epidemiology, impact on citizen health and prevention. *Aliment Pharmacol Ther.* 2003;18 Suppl 3:71-4.
7. Commane D, Arasaradnam R, Mills S, et al. Diet, ageing and genetic factors in the pathogenesis of diverticular disease. *World J Gastroenterol.* 2009;15:2479-88.
8. Rosemar A, Angerås U, Rosengren A. Body mass index and diverticular disease: a 28-year follow-up study in men. *Dis Colon Rectum.* 2008;51:450-5.
9. Strate LL, Liu YL, Aldoori WH, et al. Obesity increases the risks of diverticulitis and diverticular bleeding. *Gastroenterology.* 2009;136:115-22.
10. Dobbins C, Defontgalland D, Duthie G, et al. The relationship of obesity to the complications of diverticular disease. *Colorectal Dis.* 2006;8:37-40.
11. Beasley LE, Koster A, Newman AB, et al. Inflammation and race and gender differences in computerized tomography-measured adipose depots. *Obesity.* 2009;17:1062-9.
12. Wang Z, Nakayama T. Inflammation, a link between obesity and cardiovascular disease. *Mediators Inflamm.* 2010;2010:535918.
13. Fontana L, Eagon JC, Trujillo ME, et al. Visceral fat adipokine secretion is associated with systemic inflammation in obese humans. *Diabetes.* 2007;56:1010-3.
14. John BJ, Irukulla S, Abulafi AM, et al. Systematic review: adipose tissue, obesity and gastrointestinal diseases. *Aliment Pharmacol Ther.* 2006;23:1511-23.
15. Narayan R, Floch MH. Microscopic colitis as part of the natural history of diverticular disease. *Am J Gastroenterol.* 2002;97: S112-S113.
16. Tomita R, Fujisaki S, Tanjoh K, et al. Role of nitric oxide in the left-sided colon of patients with diverticular disease. *Hepatogastroenterology.* 2000;47:692-6.
17. Tomita R, Tanjoh K, Fujisaki S, et al. Physiological studies on nitric oxide in the right sided colon of patients with diverticular disease. *Hepatogastroenterology.* 1999;46:2839-44.
18. Vlachos I. Sonographic assessment of regional adiposity. *AJR.* 2007;189:1545-53.
19. Ribeiro-Filho F, Faria A, Kohlmann Jr, et al. Ultrasonography for the evaluation of visceral fat and cardiovascular risk. *Hypertension.* 2001;38:713-17.