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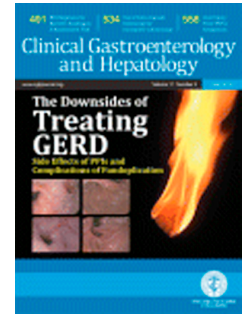
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High risk of anal and rectal cancer in patients with anal and/or perianal Crohn's disease

Short title: Anorectal cancers in anal and/or perianal Crohn's disease

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Abbreviations used in this paper:

CD, Crohn's disease ;

CESAME, Cancers Et Surrisque Associé aux Maladies inflammatoires intestinales En France;

HPV, Human Papilloma Virus

IBD, Inflammatory Bowel Disease

IRR, Incidence Rate Ratio

SCC, Squamous-Cell Carcinoma

SD, Standard Deviation

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Author contributions: LB and FC were jointly responsible for the study concept, design and implementation. LB was responsible for the writing of the first draft of the report. FC and JK were responsible for statistical analyses. All authors took part in the revision of the manuscript.

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ABSTRACT

Background and Aims: Little is known about the magnitude of the risk of anal and rectal cancer in patients with anal and/or perineal Crohn's disease. We aimed to assess the risk of anal and rectal cancer in patients with Crohn's perianal disease followed in the Cancers Et Surrisque Associé aux Maladies inflammatoires intestinales En France (CESAME) cohort.

Methods: We collected data from 19,486 patients with Inflammatory Bowel Disease (IBD) enrolled in the observational CESAME study in France, from May 2004 through June 2005; 14.9% of participants had past or current anal and/or perianal Crohn's disease. Subjects were followed for a median time of 35 months (interquartile range, 29-40 months). To identify risk factors for anal cancer in the total CESAME population, we performed a case-control study in which participants were matched for age and sex.

Results: Among the total IBD population, 8 patients developed anal cancer and 14 patients developed rectal cancer. In the subgroup of 2911 patients with past or current anal and/or perianal Crohn's lesions at cohort entry, 2 developed anal squamous-cell carcinoma, 3 developed perianal fistula-related adenocarcinoma, and 6 developed rectal cancer. The corresponding incidence rates were 0.26/1000 patient-years for anal squamous-cell carcinoma, 0.38/1000 patient-years for perianal fistula-related adenocarcinoma, and 0.77/1000 patient-years for rectal cancer. Among the 16,575 patients with ulcerative colitis or Crohn's disease without anal or perianal lesions, the incidence rate of anal cancer were 0.08/1000 patient-years and of rectal cancer was 0.21/1000 patient-years. Among factors tested by univariate conditional regression (IBD subtype, disease duration, exposure to immune-suppressive therapy, presence of past or current anal and/or perianal lesions), the presence of past or current anal and/or

perianal lesions at cohort entry was the only factor significantly associated with development of anal cancer (odds ratio, 11.2; 95%CI, 1.18-551.51) ($P = .03$).

Conclusion: In an analysis of data from the CESAME cohort in France, patients with anal and/or perianal Crohn's disease have a high risk of anal cancer, including perianal fistula-related cancer, and a high risk of rectal cancer.

Key words: carcinogenesis; inflammation; HPV

Summary

The magnitude of the risk of anorectal cancer in patients with anal/perianal Crohn's disease was unknown. Using data of the CESAME cohort, we show that patients with anal and/or perianal Crohn's disease are at high risk of both anal and rectal cancer

The risk of anal squamous-cell carcinoma (SCC) is low in general population¹. A mild increase in this risk has been reported in patients with Crohn's disease in a meta-analysis of inflammatory bowel disease (IBD) referral center series,² possibly attributable to Human Papilloma Virus (HPV) infection and chronic inflammation of anal mucosa.^{3,4} Patients with perianal fistulizing Crohn's disease are also at risk of perianal fistula-related SCC and adenocarcinoma.⁵ Since anal and/or perianal Crohn's disease is associated in most cases with chronic inflammation of rectal mucosa, patients with chronic anal and/or perianal Crohn's disease are also theoretically at increased risk of rectal cancer. To date, the magnitude of these risks was unknown at a population level because IBD phenotype is a missing data in national registries and medico-administrative databases. We could assess specifically the risks of any malignancy in patients with anal and/or perianal Crohn's disease in the French nationwide CESAME observational cohort (Cancers Et Surrisque Associé aux Maladies inflammatoires intestinales En France) because the presence of past or current anal and/or perianal lesions was noted at entry into the prospective observational period. In this study, we report the magnitude of the risk of anal and rectal cancer in the subgroup of patients with Crohn's perianal disease followed in the CESAME observational cohort.

METHODS

Experimental design of the CESAME cohort

From May 2004 to June 2005, 680 French gastroenterologists (38.4% with a full-time hospital practice, 24.3% with a mixed with public/private practice, and 37.3% with a full-time private practice) enrolled, on an unpaid basis, 19,486 consecutive IBD patients from their individual practices. There were no exclusion criteria.

Data were collected on an electronic case report form. The patients' demographic characteristics, IBD type, date of diagnosis, cumulative disease location (small bowel, colon (more or less than 50% of the total mucosal area affected, estimated from macroscopic or microscopic findings), or anus), previous history of cancer, and exposure to immune-suppressive therapy were recorded at the time of inclusion in the cohort. The gastroenterologists were asked to report all cases of high grade dysplasia, cancer or death among their patients during the follow-up period, and to provide information on each surviving patient, obtained during a final visit between 1 January and 31 December 2007. They were also asked to record all changes in immune-suppressive treatment status at interim visits. The follow-up period ended on 31 December 2007. Follow-up was complete (i.e. included the final visit) in 16,459 cases (84.5%), partial (interim visits but no final visit) in 588 cases (3.0%), and non-existent in 2439 cases (12.5%). The median follow-up of the overall population was 35 months (inter-quartile range [IQR], 29-40).

The protocol was approved by the institutional review boards of the French National Society of Gastroenterology, Association François Aupetit (the French IBD patient association), and Groupe d'Etude Thérapeutique des Affections Inflammatoires du Tube Digestif (GETAID). The study was authorized by the French Data Protection Agency (CNIL, registration number #04-1239, dated 6 July 2004). The patients' specific written informed consent was not required for this observational study.

Characterization of the cases of anal cancer and rectal cancer in patients with anal/perianal Crohn's disease

Clinical characteristics of patients with Crohn's disease and past or current anal and/or perianal lesions at entry into the observational period of the CESAME cohort, and who developed anal cancer or rectal high-grade dysplasia or cancer during the follow-up, were reviewed by a senior gastroenterologist (LB). Pathological reports of biopsy and/or surgical specimens were reviewed jointly by a senior gastroenterologist (LB) and a senior pathologist (MS).

Statistical analysis

To identify risk factors for anal cancer in the total CESAME population, we used a nested case-control (four controls for one case) study matched for age and sex. We tested by univariate exact conditional regression the following item: IBD subtype, disease duration, any exposure to immune-suppressive therapy at cohort entry, presence of past or current anal and/or perianal lesions at cohort entry

RESULTS

Demographics of the CESAME cohort

Of the 19,486 CESAME patients, 45.1% were male, 60.3% had Crohn's disease, and 39.7% had ulcerative colitis or IBD,unclassified. Details of patient characteristics and exposure to various immune-suppressive drugs at cohort entry according to the IBD subtype are shown in Table 1 and 2. Most (83%) of the patients receiving any immune-suppressive drug were receiving thiopurines, either alone or in combination with anti-TNF agents in 90.2% and 9.8% of the cases, respectively.

Characteristics of CESAME patients with anal and/or perianal Crohn's disease and incidence of anal and rectal cancers in this population

Among the 11,759 patients with Crohn's disease enrolled in the CESAME cohort, 2911 (24.8%) had previous or current anal and/or perianal lesions at entry into the observational period. In this subgroup, 1178 (40.5%) were males, mean (standard deviation (SD)) age of patients was 36.8 (14.6) years. Mean (SD) disease duration from diagnosis to entry into the observational period was 10.6 (2.1) years. No past or current involvement of rectum and colon at cohort entry was noted in 475 (16.3%) patients. An estimated cumulative proportion of mucosal colorectal area macroscopically or microscopically affected by IBD at cohort entry $<50\%$ or $\geq 50\%$ was observed in 950 (32.6%) and 1486 (51.1%) patients, respectively.

Among the 2911 patients with Crohn's disease and previous or current anal and/or perianal lesions at entry into the observational period, followed for a total 7830 patient-years, two patients were diagnosed with anal SCC, three with perianal fistula-related anal adenocarcinoma and six with rectal adenocarcinoma. Incidence rates (Figure 1) were 0.26/1000 patient-years (95% confidence interval [CI], 0.03-0.92) for anal SCC, 0.38/1000 patient-years (95% CI, 0.08-1.12) for perianal fistula-related adenocarcinoma, and 0.77/1000 patient-years (95% CI, 0.28-1.67) for rectal adenocarcinoma (Table 3). The total incidence rate of anorectal cancers was 1.40/1000 patient-years (95% CI, 0.70-2.51). For the purpose of comparison between risk levels, the risk of colon cancer in patients with anal and/or perianal Crohn's disease (0.13/1000 patient-years (95% CI, 0.003-0.711) was also plotted in Figure 1.

Incidence of anal and rectal cancer in patients with ulcerative colitis, IBD,unclassified or Crohn's disease without anal or perianal lesions

The remaining 16,575 individuals of the CESAME cohort population comprised 7727 patients with ulcerative colitis (n=7044) or IBD,unclassified (n=683), and 8848 patients with Crohn's disease without previous or current anal or perianal lesions at entry into the observational period. In this population, three patients were diagnosed with anal SCC and eight with rectal adenocarcinoma. Corresponding incidence rates were respectively 0.08/1000 patient-years (95% CI, 0.02-0.23) and 0.21/1000 patient-years (95% CI, 0.09-0.42).

Risk factors for anal cancer in the total CESAME

To identify risk factors for anal cancer in the total CESAME population, we used a nested case-control (four controls for one case) study matched for age and gender. Among the factors tested by univariate exact conditional regression (IBD subtype, disease duration, any exposure to immune-suppressive therapy at cohort entry, presence of past or current anal and/or perianal lesions at cohort entry), presence of past or current anal and/or perianal lesions at cohort entry was the sole factor significantly predictive for anal cancer (odds ratio, 11.2; 95%CI, 1.18-551.51) ($P = .03$).

Incidence of anal or rectal high-grade dysplasia

No case of incident anal high-grade dysplasia was reported in the CESAME population. Incident rates of rectal high-grade dysplasia by IBD phenotype are indicated in Table 3.

Incidence Rate Ratios (IRR) of anorectal cancers in patients with Crohn's disease and anal and/or perianal lesions

The IRR of subtypes of anorectal cancers diagnosed in patients with Crohn's disease and anal and/or perianal lesions, compared to patients with Crohn's disease without anal or perianal lesions, and to patients with ulcerative colitis or IBD, unclassified, are listed in Table 4.

Characteristics of incident cases of anal cancer and rectal high-grade dysplasia or cancer in patients with Crohn's disease and anal and/or perianal lesions

Ten out of the 12 patients who developed anal or rectal high grade dysplasia or cancer had active local mucosal inflammation at diagnosis of cancer (Table 5). The nine patients who were diagnosed with perianal fistula-related adenocarcinoma (n=3) or rectal adenocarcinoma (n=6) during the follow-up had a median age of 46 years at diagnosis of cancer (range, 28-55 years), and a median disease duration of 14 years at diagnosis of cancer (range, 9-26 years). One of the three patients diagnosed with perianal fistula-related adenocarcinoma had a recto-vaginal fistula, and another one a pre-existing chronic anorectal stricture. The three patients diagnosed with perianal fistula-related adenocarcinoma had mucinous adenocarcinomas, defined according to the World Health Organization as tumors having pools of mucus with either disrupted tubules and/or interstitial mucus in more than 50% of the neoplasm.⁶ This was also the case for two out of the six cases of rectal adenocarcinoma.

DISCUSSION

To our knowledge, our study provides the first estimation of the risk of anal and rectal cancer in patients with Crohn's disease and anal and/or perianal lesions. We show a high incidence rate of anorectal cancer, exceeding that of sporadic colorectal cancer in general population⁷ and in total IBD population^{8,9}. Patients who develop perianal fistula-related or rectal adenocarcinoma are typically young patients with longstanding anorectal inflammation.

Our study has several limitations. The study population, defined as patients with any anal and/or perianal lesions from diagnosis of Crohn's disease to cohort entry included patients with chronic anal and/or perianal lesions and patients with transient sporadic primary anal lesions or suppurative perianal lesions. Excluding these latter patients from analysis would lead to higher incidence of cancers and reinforce the global alarming result of our study. Another limitation is that CESAME is a nationwide cohort, but not a population-based one. However, two-thirds of the CESAME investigators were gastroenterologists with partial or pure private practice, and the observed incidences of colorectal cancer in CESAME⁸ were identical to those reported in the literature.^{9,10} By contrast to previous CESAME studies on organ malignancies^{8,11,12}, we could not provide here standardized incidence ratios because, in The French network of cancer registries, anal squamous cell carcinomas are pooled with skin cancers and rectal cancers are not individualized among colorectal cancers. From a methodological point of view, we acknowledge that the low absolute number of events in the study population may lead to imprecise estimates of incidence rate ratios. Finally the mucosal HPV status of our patients was unknown and we were unable to address the role of smoking habits and family history of colorectal cancer since these data were not recorded at cohort entry. In the ongoing European cohort study I-CARE (Ibd CAncer and seRious infections in

Europe, <https://clinicaltrials.gov/ct2/show/NCT02377258>), these factors will be taken into account.

We observed an incident rate of SCC higher than in general population,¹ but close to that reported in meta-analyses in Crohn's disease population.² This excess incidence is attributed to a conjunction of HPV infection and chronic local inflammation,^{3,4,13} The resulting incidence remains low, but could be attenuated in the future by the impact of HPV vaccination,¹⁴ and does not justify now per se surveillance programs.³ By contrast, the burden of anal cancers that are diagnosed in patients with Crohn's anal and/or perianal disease raises challenging questions of clinical practice. We also observed a high rate of rectal cancer in patients with anal and/or rectal Crohn's lesions, exceeding that observed in patients with ulcerative colitis at highest risk of colorectal cancer, i.e. those with longstanding extensive colitis.¹⁰ Overall, in patients with anal and/or perianal Crohn's disease, the risk of anorectal cancer was eleven times greater than the risk of colon cancer.

Thus, there is now a solid epidemiologic and pathogenesis rationale (dysplasia-cancer sequence in chronically inflamed lesions and fistula tracts)¹⁵ for building surveillance programs in order to detect premalignant dysplastic lesions and early anorectal cancers in patients with longstanding anal and/or perianal Crohn's disease. At this time, optimal frequency and modalities of surveillance are unknown.^{3,16} In addition, the frequent presence of anorectal impassable strictures,¹⁷ and initial location of malignant lesions in inaccessible fistula tracts make the surveillance difficult, if not, in some cases, impossible.^{18,19} Dedicated consensus and guidelines regarding detection of advanced anorectal neoplasia in patients with anal and/or perianal Crohn's disease are now eagerly awaited.

Acknowledgments

The list of CESAME Study Group collaborators appears in the Supplementary Material

ACCEPTED MANUSCRIPT

Figure legends

Figure 1: Incidence rates of anal squamous-cell carcinoma, perianal fistula-related adenocarcinoma, rectal adenocarcinoma and colon carcinoma, in 2911 patients of the CESAME cohort with Crohn's disease and past or current anal and/or perianal lesions at entry into the observational period, followed for 7830 patient-years.

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Table 1. Characteristics of the CESAME patient population

| | Thiopurine therapy at entry | | | |
|--|-----------------------------|--------------------------|------------------------------|---------------------|
| | Ongoing (N=5867) | Discontinued (N=2809) | Never received (N=10,810) | Total (N=19,486) |
| Age (years) | 37.0 (14.3) | 39.5 (14.4) | 42.3 (16.3) | 40.3 (15.6) |
| Male sex | 2592 (44.2%) | 1142 (40.7%) | 5046 (46.7%) | 8780 (45.1%) |
| Age at onset of disease (years) | 28.6 (13.2) | 29.0 (13.4) | 34.9 (15.1) | 32.1 (14.6) |
| Duration of disease (years) | 8.4 (7.2) | 10.5 (7.8) | 7.4 (8.4) | 8.2 (8.0) |
| Crohn's disease | 4452 (75.9%) | 2154 (76.7%) | 5153 (47.7%) | 11,759 (60.3%) |
| Disease location | | | | |
| Ileum | 3082 (52.5%) | 1543 (54.9%) | 3597 (33.3%) | 8222 (42.2%) |
| Colon (<50%)* | 1358 (23.1%) | 627 (22.3%) | 1876 (17.4%) | 3861 (19.8%) |
| Colon (>50%) | 2079 (35.4%) | 1085 (38.6%) | 1426 (13.2%) | 4590 (23.6%) |
| Anal/Perianal | 1384 (23.6%) | 740 (26.3%) | 787 (7.3%) | 2911 (14.9%) |
| Ulcerative colitis or inflammatory bowel disease unclassified | 1415 (24.1%) | 655 (23.3%) | 5657 (52.3%) | 7727 (39.7%) |
| Colon (<50%)* | 578 (9.9%) | 237 (8.4%) | 3883 (35.9%) | 4698 (24.1%) |
| Colon (>50%) | 837 (14.3%) | 418 (14.9%) | 1774 (16.4%) | 3029 (15.5%) |
| Past history of cancer | 83 (1.4%) | 77 (2.7%) | 302 (2.8%) | 462 (2.4%) |
| Follow-up (months) | 35.7 (31.1-40.1) | 35.4 (29.9-40.0) | 34.3 (27.7-39.1) | 35.0 (29.2-39.5) |

Data are Mean (SD) or number (%) or Median (IQR)

* estimated cumulative proportion of mucosal area macroscopically or microscopically involved

Table 2. Immune-suppressive drug exposure status of the CESAME population at entry to the cohort

| | Exposure to immune-suppressive therapy | | |
|---|--|--|------------------|
| | Crohn's disease (n=11,759) | Ulcerative colitis or IBDU (n=7727) | All (n=19486) |
| Thiopurines | | | |
| Ongoing, n (%) | 4452 (37.9) | 1415 (18.3) | 5867 (30.1) |
| Discontinued, n (%) | 2154 (18.3) | 655 (8.5) | 2809 (14.4) |
| Never received, n (%) | 5153 (44.8) | 5657 (73.2) | 10810 (55.5) |
| Methotrexate | | | |
| Ongoing, n (%) | 600 (5.1) | 94 (1.2) | 694 (3.6) |
| Discontinued, n (%) | 617 (5.3) | 82 (1.1) | 699 (3.6) |
| Never received, n (%) | 10542 (89.6) | 7551 (97.7) | 18093 (92.8) |
| Anti-TNF agents | | | |
| Ongoing, n (%) | 877 (7.5) | 48 (0.6) | 925 (4.7) |
| Discontinued, n (%) | 929 (7.9) | 85 (1.1) | 1014 (5.2) |
| Never received, n (%) | 9953 (84.6) | 7594 (98.3) | 17547 (90.1) |
| Other immunosuppressants^a | | | |
| Continuing, n (%) | 77 (0.7) | 119 (1.5) | 197 (1.0) |
| Discontinued, n (%) | 179 (1.5) | 301 (3.9) | 480 (2.5) |
| Never received, n (%) | 11503 (97.8) | 7307 (94.6) | 18809 (96.5) |

IBDU, Inflammatory Bowel Disease Unclassified.

^a Ciclosporin, mycophenolate mofetil or cyclophosphamide.

Table 3. Incident rates of rectal high-grade dysplasia and rectal cancer in the CESAME cohort by IBD phenotype

| | Patient-years | Rectal high-grade dysplasia (n/1000 PY (95% CI)) | Rectal cancer (n/1000 PY (95% CI)) |
|--|---------------|---|---------------------------------------|
| Crohn's disease | | | |
| All (n=11759) | 27,828 | 0.072 (0.009-0.260) | 0.323 (0.148-0.614) |
| With anal and/or perianal lesions ^a (n=2911) | 7830 | 0.128 (0.003-0.711) | 0.766 (0.281-1.667) |
| Without anal or perianal lesions ^a (n=8848) | 19,998 | 0.050 (0.001-0.279) | 0.150 (0.031-0.438) |
| Ulcerative Colitis or IBD, unclassified | | | |
| All (n=7727) | 17,666 | 0.170 (0.035-0.496) | 0.283 (0.092-0.660) |
| With longstanding extensive colitis ^b (n=1083) | 2571 | 0.778 (0.094-2.807) | 0.389 (0.010-2.165) |
| Without longstanding extensive colitis (n=6644) | 15,095 | 0.066 (0.002-0.369) | 0.265 (0.072-0.678) |

CI, Confidence interval; IBD, Inflammatory Bowel Disease; PY, Patient-years;

^a at entry into the observational period of the CESAME cohort

^b defined as IBD duration greater than 10 years and an estimated cumulative proportion of mucosal area macroscopically or microscopically effected by IBD or greater than or equal to 50%

Table 4. Incidence Rate Ratios of anorectal cancers in patients with Crohn's disease and anal and/or perianal lesions compared to other IBD subgroups

| | Compared to patients with Crohn's disease without anal and/or perianal lesions (IRR (95% CI)) | Compared to patients with ulcerative colitis or IBD, <i>unclassified</i> (IRR (95% CI)) |
|--|---|---|
| Anal cancers | | |
| Anal squamous cell carcinoma | — ^a | 1.50 (0.25-9.00) |
| Perianal fistula-related anal adenocarcinoma | — ^a | — ^b |
| All anal cancers | — ^a | 3.76 (0.90-15.73) |
| Rectal cancers | 5.11 (1.28-20.42) | 2.71 (0.83-8.87) |
| All anorectal cancers | 9.36 (2.61-33.54) | 3.10 (1.25-7.71) |

IRR, Incidence Rate Ratio; IBD, Inflammatory Bowel Disease; CI, Confidence interval;

^a No case was diagnosed in patients with Crohn's disease without anal or perianal lesions

^b No case was diagnosed in patients with ulcerative colitis or IBD, *unclassified*

Table 5. Characteristics of incident cases of anal cancer and rectal high-grade dysplasia or cancer in patients with Crohn's disease and past or current anal and/or perianal lesions at entry into the CESAME cohort (7830 patient-years).

| | Age (years) at diagnosis of neoplasia | Sex | Cumulative location of Crohn's lesions at cohort entry | Crohn's disease duration diagnosis of neoplasia (years) | Active local mucosal inflammation at diagnosis of neoplasia | History of chronic perianal fistulas at diagnosis of neoplasia | History of chronic anorectal stricture at diagnosis of neoplasia | Exposure to immune-suppressive therapy at diagnosis of neoplasia |
|---|---------------------------------------|-----|--|---|---|--|--|--|
| Patients with anal squamous-cell carcinoma | | | | | | | | |
| 1 | 49 | M | Colon <50% ^a , anus ^b | 2 | Yes ^c | No | No | AZA |
| 2 | 73 | F | Anus | 3 | No | No | No | 0 |
| Patients with perianal fistula-related adenocarcinoma | | | | | | | | |
| 3 ^e | 37 | F | Small bowel, colon >50%, | 9 | Yes ^c | Yes (rectovaginal) | No | 0 |
| 4 ^e | 38 | M | Anus | 22 | Yes ^c | Yes | Yes | 0 |
| 5 ^e | 46 | M | Colon >=50%, anus Small bowel, colon >=50%, anus | 28 | Yes ^c | Yes | No | AZA |
| Patients with rectal adenocarcinoma | | | | | | | | |
| 6 ^e | 28 | M | Colon >=50%, anus | 10 | Yes ^d | Yes | No | AZA + IFX |
| 7 | 28 | M | Colon >=50%, anus | 9 | Yes ^d | No | No | MTX + IFX |
| 8 ^e | 48 | F | Colon >=50%, anus | 14 | Yes ^d | No | No | MTX |
| 9 | 48 | F | Anus | 19 | No | Yes | No | 0 |
| 10 | 51 | M | Colon >=50%, anus | 26 | Yes ^d | No | Yes | 0 |
| 11 | 55 | M | Colon >=50%, anus | 10 | Yes ^d | No | No | 0 |
| Patients with rectal high-grade dysplasia | | | | | | | | |
| 12 | 54 | M | Colon >=50%, anus | 24 | Yes ^d | Yes | No | IFX |

IBD, inflammatory bowel disease; M, male; F, female; AZA, azathioprine; IFX, infliximab; MTX, methotrexate

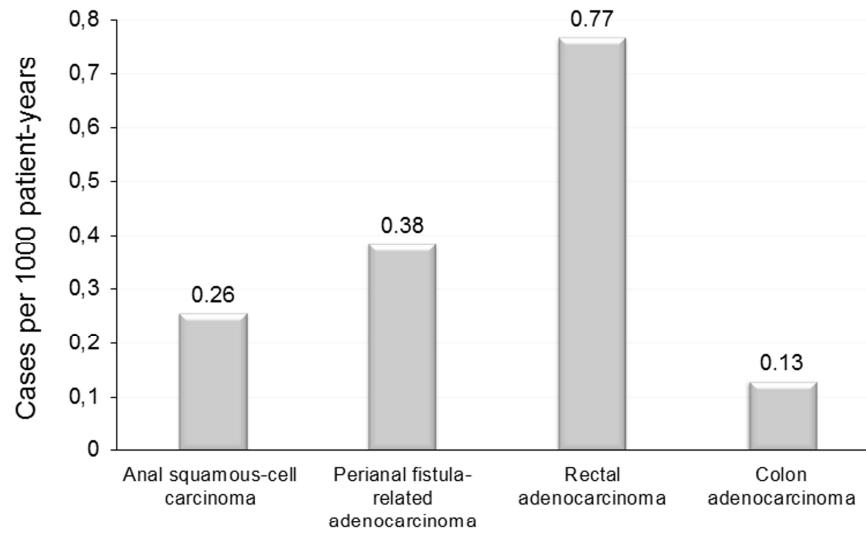
^a Estimated cumulative proportion of mucosal colorectal area macroscopically or microscopically affected by IBD

^b Anal and/or perianal lesions.

^c Inflammation of anal canal mucosa

^d Inflammation of rectal mucosa

^e Mucinous adenocarcinoma



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