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Original Article

# Incidental findings of coronary computed tomography angiography

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## ABSTRACT

**INTRODUCTION.** The use of coronary CT angiography (CCTA) is increasing in Denmark, which leads to more incidental extracardiac findings (ECF), especially lung nodules. While ECF often need further investigation, only a small percentage is ultimately confirmed to be cancer. This study investigates ECF found on CCTA and presents information about patients ultimately diagnosed with cancer.

**METHODS.** This registry-based retrospective study included data from 1 January 2018 to 31 December 2022 from the Department of Cardiology and Endocrinology at the North Denmark Regional Hospital. The patients' personal identification numbers (CPR numbers) were used to obtain data in the electronic patient journal systems. The ECF and characteristics of the patients with cancer are presented in tables using descriptive statistics.

**RESULTS.** In the study period, 2,635 patients underwent CCTA. ECF were identified in 643 patients and were predominantly lung nodules (40.9%). A total of 406 patients (63.1%) were referred for an acute lung cancer conference and/or to a control programme. Among patients who underwent CCTA (2,635), 17 (0.65%) were diagnosed with cancer.

**CONCLUSIONS.** ECF are common incidental findings in CCTA. However, in our study, only 0.65% of the ECF were subsequently identified as cancer.

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**TRIAL REGISTRATION.** The use of the data in this quality assurance study was approved by the participating hospitals and by the Data Responsible Unit of the North Denmark Region (approval No. K2023-066).

Coronary computed tomography angiography (CCTA) was introduced in Denmark in 2008 [1]. The use of CCTA has risen in recent years for primary evaluation of patients with a low to intermediate risk of coronary artery disease and is the first-choice method for examining patients with suspected stable angina pectoris [1, 2].

Data from the Danish Heart Registry confirm that the number of CCTA procedures in Denmark increased by 36.27% from 2014 to 2023 [3]. Furthermore, data from the Department of Cardiology and Endocrinology at North Denmark Regional Hospital show a similar increase of 32.02% in the same period [3].

Although CCTA primarily focuses on the heart, thereby describing coronary arteries, extracardiac structures in the lungs and abdomen are also visualised and described in the final report. As the use of CCTA as a diagnostic tool increases, there is also a rising number of extracardiac findings (ECF) [4].

ECF are common anomalies that, although unrelated to the primary focus of the investigation, can reveal other pathologies and raise suspicion of malignancy, e.g. lung cancer [1, 5]. Therefore, ECF often require further

investigations with additional imaging, exposing the patient to potential extra radiation, clinical follow-up and waiting time, which frequently leads to anxiety in the patient [5]. Additional examinations are known to result in higher costs and demand more healthcare personnel resources [6].

To our knowledge, there is limited data regarding ECF found on CCTA in Denmark. Therefore, we aimed to outline the number of patients who underwent CCTA and further diagnostic investigations due to ECF. Specifically, we aimed to describe patients who were diagnosed with cancer owing to the ECF in this population.

## Methods

### Settings

This was a registry-based retrospective study conducted over a five-year period. We included all patients referred for CCTA at the North Denmark Regional Hospital from 1 January 1 2018 to 31 December 2022. To follow patients with ECF, the study period for patients with ECF was extended to 1 November 2023. The extended follow-up period allowed comprehensive information regarding the diagnostic process, treatment and outcome.

### Study design

All living citizens residing in Denmark have a unique personal identification number (CPR number), which serves as the primary means of identification in all interactions with healthcare providers and various government and social organisations [7]. The CPR number contains historical and current personal information such as name, sex, date of birth, address and healthcare data. We identified the study population using the CCTA procedure code (UXC00A), which provided access to patient characteristics and outcome using their CPR numbers in the electronic patient journal systems employed at the North Denmark Regional Hospital. In Danish healthcare, procedure codes are used for patient documentation and for the registration of procedure costs [8].

### Study population

The study population comprises all patients aged 18 years or older referred for CCTA during the study period. Patients who did not undergo the CCTA procedure for various reasons and patients in whom ECF were not found were excluded from further investigations.

We included the most common ECF, such as lung findings (nodules, atelectasis, fibrosis, infiltrate, emphysema and bullae), dilated aorta, hiatus hernia, lymphadenitis and liver cysts. The inclusion of these ECFs was based on previous investigations that found them to be the most common incidental ECFs on CCTA [5]. We included all findings reported by the descriptive radiologist, regardless of size or appearance. It was then up to the descriptive radiologist to assess whether further investigation was needed. Some of the above-mentioned ECFs, such as hiatus hernia and atelectasis, were interpreted as expected benign findings.

We examined how many patients with ECF were referred to the acute lung cancer conference (ALC) or designated to an individual control programme, and how many of them were subsequently diagnosed with cancer. The study focused on the final diagnosis. The diagnostic process falls beyond the scope of the article. It was up to the radiologist to decide whether a patient should be assigned to the ALC or the control programme. The ALC is a multidisciplinary diagnostic unit in the North Denmark Region, the purpose of which was to determine if the patient should be further referred for additional lung cancer investigations [1, 9].

Finally, patients who subsequently received a cancer diagnosis were investigated with descriptions of their patient characteristics, including the type of cancer and treatment outcomes.

### Statistics

In this study, we employed descriptive statistics. Frequencies and percentages were computed for categorical data. Age was represented by mean values along with minimum and maximum values. All statistical analyses were performed using Microsoft Excel, Microsoft Corporation (2018).

### Ethics

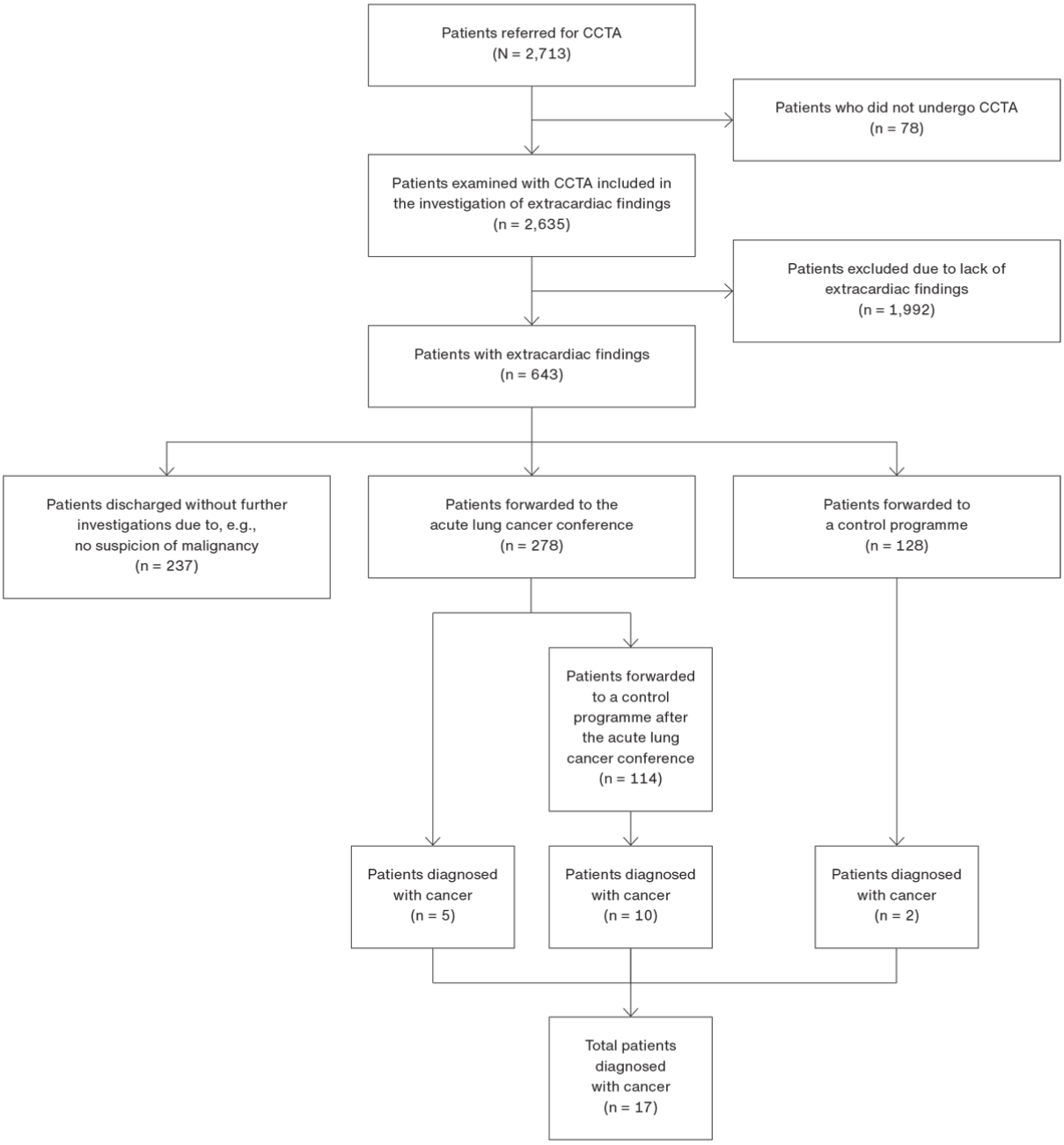
The study population was anonymised after data collection, in accordance with the General Data Protection Regulation [10].

*Trial registration*: The use of the data in this quality assurance study was approved by hospitals and by the Data Responsible Unit of the North Denmark Region (approval no. K2023-066).

## Results

A total of 2,713 patients were referred for CCTA, but only 2,635 underwent the procedure (**Figure 1**).

**FIGURE 1** Flow chart of the procedure.




CCTA = coronary CT angiography.

### Patients with extracardiac findings found on coronary computed tomography angiography

Among 2,635 CCTA procedures, ECF were described in 643 (24.4%) patients. The most frequent findings in the lungs were nodules (40.9%), atelectasis (15.2%) and fibrosis (7.8%). Findings outside the lungs included, e.g., dilated aorta (19.4%) and hiatus hernia (14.8%) (**Table 1**). Among the ECF,36.9% (n = 237) required no further investigations as there was no suspicion of malignancy, whereas 63.1% (n = 406) of the ECF were referred to the ALC and/or to a control programme. Among all the patients who underwent CCTA (n = 2,635), 17 (0.65%) were diagnosed with cancer (Figure 1).

**TABLE 1** Extracardiac findings (ECF) in patients who underwent coronary computed tomography angiography (N = 2,635).

| | n (%) |
|---|---|
| Patients with ECF, total | 643 (24.4) |
| *Pulmonary ECF* | |
| Nodules | 263 (40.9) |
| Atelectasis | 98 (15.2) |
| Fibrosis | 50 (7.8) |
| Infiltrate | 45 (7.0) |
| Emphysema | 24 (3.7) |
| Bullae | 16 (2.5) |
| Patients with ECF in lungs, total | 496 (77.1) |
| *Extrapulmonary ECF* | |
| Dilated aorta | 125 (19.4) |
| Hiatus hernia | 95 (14.8) |
| Lymphadenitis | 56 (8.7) |
| Liver cysts | 45 (7.0) |

**Characteristics of patients diagnosed with cancer based on extracardiac findings**

Patients characteristics of the 17 patients diagnosed with cancer are presented in **Table 2.** Six patients (35.3%) were current smokers, seven (41.2%) were former smokers, and four (23.5%) had never smoked. Totally, 12 (70.6%) patients had a family history of cancer, and five (29.4%) had a prior or current cancer diagnosis at the time of the CCTA procedure. Five (29.4%) of the patients were diagnosed with non-small cell lung cancer (NSCLC) without metastasis, three (17.7%) had previously been diagnosed with NSCLC with metastasis and three (17.7%) had metastatic cancer from a previously diagnosed primary cancer.

**TABLE 2** Description of patients who were diagnosed with cancer based on extracardiac findings found on coronary computed tomography angiography (N = 17).

| | |
|---|---|
| Age, mean (min.-max), yrs | 65 (53-82) |
| *Gender, n (%)* | |
| Women | 12 (70.6) |
| Men | 5 (29.4) |
| *Expositions, n (%)* | |
| Current smoker | 6 (35.3) |
| Former smoker | 7 (41.2) |
| Never smoker | 4 (23.5) |
| Exposure to asbestosis | 2 (11.8) |
| Family history of cancer | 12 (70.6) |
| Other previous or current cancer diagnosis | 5 (29.4) |
| *Type of cancer, n (%)* | |
| NSCLC without metastasis | 5 (29.4) |
| NSCLC with metastasis | 3 (17.7) |
| Metastatic cancer from already known primary cancer | 3 (17.7) |
| NSCLC + HCC | 1 (5.9) |
| NSCLC + papillary thyroid carcinoma | 1 (5.9) |
| NSCLC with metastasis + liposarcoma | 1 (5.9) |
| SCLC with metastasis | 1 (5.9) |
| HCC | 1 (5.9) |
| Follicular lymphoma | 1 (5.9) |
| *Outcome of cancer treatment, n (%)* | |
| Cancer-free | 6 (35.3) |
| Died of their cancer diagnosis | 6 (35.3) |
| Palliative treatment | 3 (17.7) |
| Watch-and-wait strategy | 1 (5.9) |
| HCC control programme out of The North Denmark Region | 1 (5.9) |

HCC = hepatocellular carcinoma; NSCLC = non-small cell lung cancer; SCLC = small cell lung cancer.

Of all patients diagnosed with cancer, 35.3% had passed away and 35.3% were declared cancer-free at the end of the study period. In addition, four patients (23.6%) lived with incurable cancer; three of these patients received palliative care and one followed a watch-and-wait strategy. Data are missing on one patient, as the control programme was conducted outside of the North Denmark Region.

## Discussion

### Frequency of extracardiac findings

In our study, we found ECF in 643 (24.4%) of 2,635 CCTA procedures. The incidence of ECF in our study is somewhat lower than other CCTA studies, reporting up to 44% ECF [11, 12].

As expected, the most common ECFs in our study were located in the lungs (77.1%), predominantly lung nodules (40.9%), which is consistent with the study by Kelion et al. [5], who found lung nodules in 41.3% of ECFs.

ECF represent a clinical challenge because, even though many of them are benign, it is crucial to identify ECF with a risk of malignancy [13]. A prior systematic review from 2013 [12] found that the pooled prevalence of previously unknown malignancies was 0.7%, with 72% of these being lung cancers. This aligns well with the findings of our study, where 70.6% of the cancer diagnoses were lung cancers. Our study contributes to the existing literature by demonstrating that only a small proportion (0.65%) of the patients undergoing CCTA were diagnosed with cancer based on ECF.

**Characteristics and outcomes of patients diagnosed with cancer**

Overall, we found that 17 patients diagnosed with cancer had one or more factors potentially predisposing to cancer development. Thus, among patients diagnosed with cancer, 76.5% had a history of smoking, 70.6% had a family history of cancer and 29.4% had a history of cancer. Within our patient population, the results regarding smoking support the association between smoking and various diseases, particularly cancer, notably lung cancer, as demonstrated in the literature [14]. Moreover, it is relevant to mention that some of the patients who had a history of cancer were diagnosed with metastases and/or primary cancer as ECF, which may indicate that previous cancer increases the risk of recurrence [1, 15, 16].

The results from our study may indicate that detecting cancer early had a more favourable outcome, since all the patients who had cancer without metastasis were declared cancer-free by the end of the study period. In contrast, all patients who had passed away by the end of the study period were diagnosed with disseminated cancer after further investigations due to suspicious ECF on the CCTA. However, we lack a five-year follow-up for all cancer patients due to the relatively short study period. As a result, we do not know if some of the patients may experience a recurrence of the cancer or die within a five-year period. Our findings suggested that CCTA procedures should consistently include an ECF analysis, and that the presence of ECF should always be reported [12].

**Ethics**

There is an ethical dilemma concerning ECF identified on CCTA, even though these are not the primary purpose of the procedure. Some patients undergo further diagnostic investigations with invasive procedures and potentially unnecessary radiation exposure and anxiety despite possibly having benign findings, which could potentially trigger serious health complications [5, 17].

It is crucial to analyse if the benefits of the additional diagnostic procedures related to the ECF outweigh the associated risks and complications, given that only 0.65% of patients referred for CCTA were diagnosed with cancer. It is important to consider the emotional impact of additional diagnostic investigations, which mostly turn out to be clinically nonsignificant [5]. To the best of our knowledge, there is limited research on this topic in Denmark, indicating that it may be a relevant area for future research.

**Economics**

In our study, we found that 406 out of 643 (63.1%) of the described ECFs required further investigations. These investigations raise substantial economic concerns for the healthcare system [5, 6, 17]. Substantial financial resources are allocated to the investigation of potential malignancies, despite 99.35% of the CCTA in our study showing no signs of malignancy.

A Danish study from 2014 [18] argued that the amount of CCTAs should be reduced. The study expressed concerns that the growing use of CCTA could lead to extra patient pathways demanding considerable personal

and financial resources.

Subsequently, a Danish study from 2022 [19] argued that ECF could have severe consequences for the patient if not followed up, particularly in relation to lung nodules that may, in some cases, indicate cancer. The paper suggested a need for follow up to exclude malignancy. The article also outlined the substantial resources required, especially from the pulmonary and radiological departments, to complete ECF follow-up. However, the considerable amount of ECF detected on CCTA places an additional burden on Danish healthcare, which is currently under considerable financial pressure. [20]. Given the results of this study, the economic justification of these ECF investigations may be questioned, as only a small proportion proves to be clinically relevant.

### Limitations and strengths

One of the limitations of the study is the five-year study period, not allowing a full follow-up on patients with a cancer diagnosis. Thus, our analysis is limited to their conditions as recorded when the study period concluded.

However, our study population was large and included all patients undergoing CCTA in the study period. Considering this, we assess that our findings are highly representative of the group of patients in which ECF were identified in our study population as in other populations. This implies that the findings may be extrapolated and used for comparison in other CCTA studies.

## Conclusions

In our study, ECF were present in 24.4% of patients who underwent CCTA. A total of 63.1% of the ECF found on CCTA require further investigations due to a suspicion of malignancy. However, malignancy was found in only 0.65% of all patients undergoing CCTA, and the most common type of cancer was lung cancer. Further investigations related to ECF can have economic, ethical and psychosocial implications for patients and the healthcare system.

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## REFERENCES

1. Fuchs A, Bøttcher M, Kristensen LD, et al. Cardiac CT. Ugeskr Læger. 2020;182:V1219067
2. Nissen L, Winther S, Schmidt M, et al. Implementation of coronary computed tomography angiography as nationally recommended first-line test in patients with suspected chronic coronary syndrome: impact on the use of invasive coronary angiography and revascularization. Eur Heart J Cardiovasc Imaging. 2020;21(12):1353-1362. https://doi.org/10.1093/ehjci/jeaa197
3. Regionernes Kliniske Kvalitetsudviklingsprogram. Årsrapport 2022. Dansk Hjerteregister. 2023:106-107

4. Arshad A, Saghir Z, Borg M, et al. Management of incidental pulmonary nodules in CT examination. Ugeskr Læger. 2024;186:V09230595. https://doi.org/10.61409/V09230595
5. Kelion A, Sabharwal N, Holdsworth D, et al. Clinical and economic impact of extracardiac lesions on coronary CT angiography. Heart. 2022;108(18):1461-1466. https://doi.org/10.1136/heartjnl-2021-320698
6. Robertson J, Nicholls S, Bardin P, et al. Incidental pulmonary nodules are common on CT coronary angiogram and have a significant cost impact. Heart Lung Circ. 2019;28(2):295-301. https://doi.org/10.1016/j.hlc.2017.11.004
7. Pedersen CB. The Danish Civil Registration System. Scand J Public Health. 2011;39(7 suppl):22-25. https://doi.org/10.1177/1403494810387965
8. Sundhedsdatastyrelsen. Sundhedsvæsenets Klassifikationssystem. https://sundhedsdatastyrelsen.dk/da/rammer-og-retningslinjer/om-klassifikationer/sks-klassifikationer (23 Jul 2024)
9. Region Nordjylland. Henvisning til Lungekræftpakken. https://pri.rn.dk/document/AALBORGUH-905462050-13571 (19 Oct 2022)
10. Datatilsynet. Hvad er personoplysninger? www.datatilsynet.dk/regler-og-vejledning/grundlaeggende-begreber/hvad-er-personoplysninger (7 Dec 2023)
11. Williams MC, Hunter A, Shah ASV, et al. Impact of noncardiac findings in patients undergoing CT coronary angiography: a substudy of the Scottish Computed Tomography of the Heart (SCOT-HEART) trial. Eur Radiol. 2018;28(6):2639-2646. https://doi.org/10.1007/s00330-017-5181-5
12. Flor N, Di Leo G, Squarza SAC, et al. Malignant incidental extracardiac findings on cardiac CT: systematic review and meta-analysis. AJR Am J Roentgenol. 2013;201(3):555-564. https://doi.org/10.2214/AJR.12.10306
13. Macmillan MT, Williams MC. Incidental non-cardiac findings in cardiovascular imaging. Curr Treat Options Cardiovasc Med. 2018;20(12):93. https://doi.org/10.1007/s11936-018-0700-5
14. Centers for Disease Control and Prevention. Lung cancer risk factors. Centers for Disease Control and Prevention, 2025. www.cdc.gov/lung-cancer/risk-factors/index.html (Jun 2025)
15. Smith BC, Allen BD. Coronary computed tomography angiography results in more computed tomography chest follow-up for incidental findings at 1 year relative to stress-perfusion cardiac magnetic resonance imaging. J Thorac Imaging. 2022;37(5):292-299. https://doi.org/10.1097/RTI.0000000000000642
16. Nielsen SF, Nordestgaard BG, Bojesen SE. Associations between first and second primary cancers: a population-based study. CMAJ. 2012;184(1):E57-E69. https://doi.org/10.1503/cmaj.110167
17. Bendix K, Jensen JM, Poulsen S, et al. Coronary dual source multi detector computed tomography in patients suspected of coronary artery disease: prevalence of incidental extra-cardiac findings. Eur J Radiol. 2011;80(1):109-114. https://doi.org/10.1016/j.ejrad.2010.05.024
18. Albinus NB, Nørgaard BL, Flensted JL. Kardiologer: Udbredelsen af hjerte-CT er sket alt for ukritisk. Dagens Medicin. 2014(5)
19. Borg M, Hilberg O, Andersen MB, et al. Increased use of computed tomography in Denmark: stage shift toward early-stage lung cancer through incidental findings. Acta Oncol. 2022;61(10):1256-1262. https://doi.org/10.1080/0284186X.2022.2135134
20. Lægeforeningen. Ny analyse: Forebyggelse kan forhindre tusindvis af indlæggelser og aflaste det pressede sundhedsvæsen. 2023. ugeskriftet.dk/nyhed/ny-analyse-forebyggelse-kan-forhindre-tusindvis-af-indlaeggelser-og-aflaste-det-pressede (8 Dec 2023)


 