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## Case Report

# Ectopic mediastinal parathyroid adenoma localized with four-dimensional CT: a case report

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## ARTICLE INFO

## Article history:

Received 15 November 2016

Received in revised form

6 January 2017

Accepted 13 January 2017

Available online 20 February 2017

## Keywords:

Ectopic parathyroid adenoma

4D CT

Primary hyperparathyroidism

## ABSTRACT

We present a case of an ectopic mediastinal parathyroid adenoma in a 58-year-old male patient. We show how different imaging modalities were successfully used to reach a diagnosis. We particularly focus on the role of four-dimensional CT scan in preoperative localization of ectopic adenomas and discuss how diverse imaging modalities can be integrated in the workup of ectopic parathyroid adenomas.

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## Introduction

Primary hyperparathyroidism is a clinical condition characterized by excess secretion of parathyroid hormone (PTH). The vast majority of cases are caused by solitary parathyroid adenoma [1,2].

In this case, we demonstrate how different imaging modalities, including four-dimensional CT (4D CT), were used for precise preoperative planning of surgical resection of a large ectopic mediastinal adenoma.

## Case report

A 58-year-old male patient presented with worsening fatigue and bilateral knee pain over the past few months. The patient

gave history of multiple bilateral renal stones in the past few years. Laboratory workup revealed elevated serum calcium of 10.9 mg/dL (reference range: 8.5–10.5 mg/dL) and elevated PTH of 99.7 pg/mL (reference range: 10–55 pg/mL). The patient was diagnosed with primary hyperparathyroidism.

Fist-line imaging workup included ultrasound and scintigraphy. Neck ultrasound showed multinodular goiter with no definite evidence of parathyroid adenoma. Dual-phase sestamibi scan was then ordered. On the immediate images, there was uniform tracer uptake in the thyroid gland as well as abnormal focal uptake in the superior mediastinum (Fig. 1A). Delayed images showed tracer washout from the thyroid gland but with persistent radiotracer uptake in the nodular lesion in the superior mediastinum (Fig. 1B). These findings were consistent with an ectopic parathyroid adenoma.

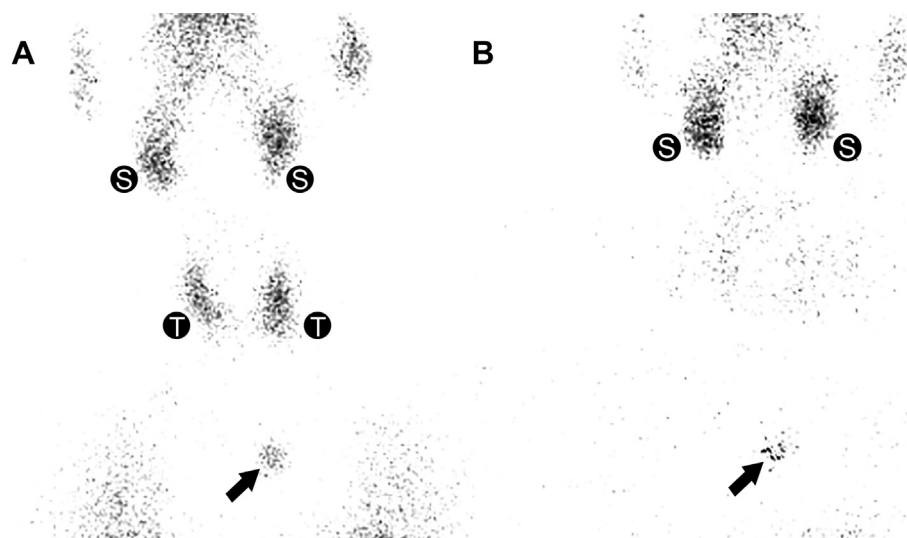
Competing Interests: The authors have declared that no competing interests exist.

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<http://dx.doi.org/10.1016/j.radcr.2017.01.011>

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**Fig. 1 – Dual-phase sestamibi scan. (A) Immediate phase scan shows tracer uptake in the thyroid gland (T), submandibular glands (S) as well as the ectopic parathyroid adenoma (arrow). (B) Delayed phase scan shows washout of contrast from the thyroid gland with residual persistent tracer uptake in the adenoma (arrow).**

4D CT scan was ordered to confirm the diagnosis and to provide accurate preoperative localization of the ectopic adenoma. CT scan showed a well-defined oval-shaped soft tissue lesion in the middle mediastinum occupying a left paratracheal location, just above the level of the carina and at the region of the aortopulmonary window. It measured approximately  $2 \times 1.5$  cm in maximum axial dimensions. The lesion was isodense on the noncontrast scan but showed intense enhancement in the arterial phase and rapid contrast washout on the subsequent delayed phases (Fig. 2). Based on the laboratory and imaging findings, the patient underwent a mediastinoscopy and surgical resection of the adenoma. Intraoperative monitoring of PTH level showed reduction of the level of PTH from a baseline level of 81 pg/mL down to 43 pg/mL at 10 minutes of postresection.

Grossly, the surgical specimen was 1.32 grams,  $2.4 \times 1.4 \times 1.1$  cm yellow to brown soft tissue. Sectioning revealed a 2.1 cm tan-brown, homogenous, surgically disrupted nodule. Microscopic findings showed a hyper cellular parathyroid tissue with minute thymic remnant.

## Discussion

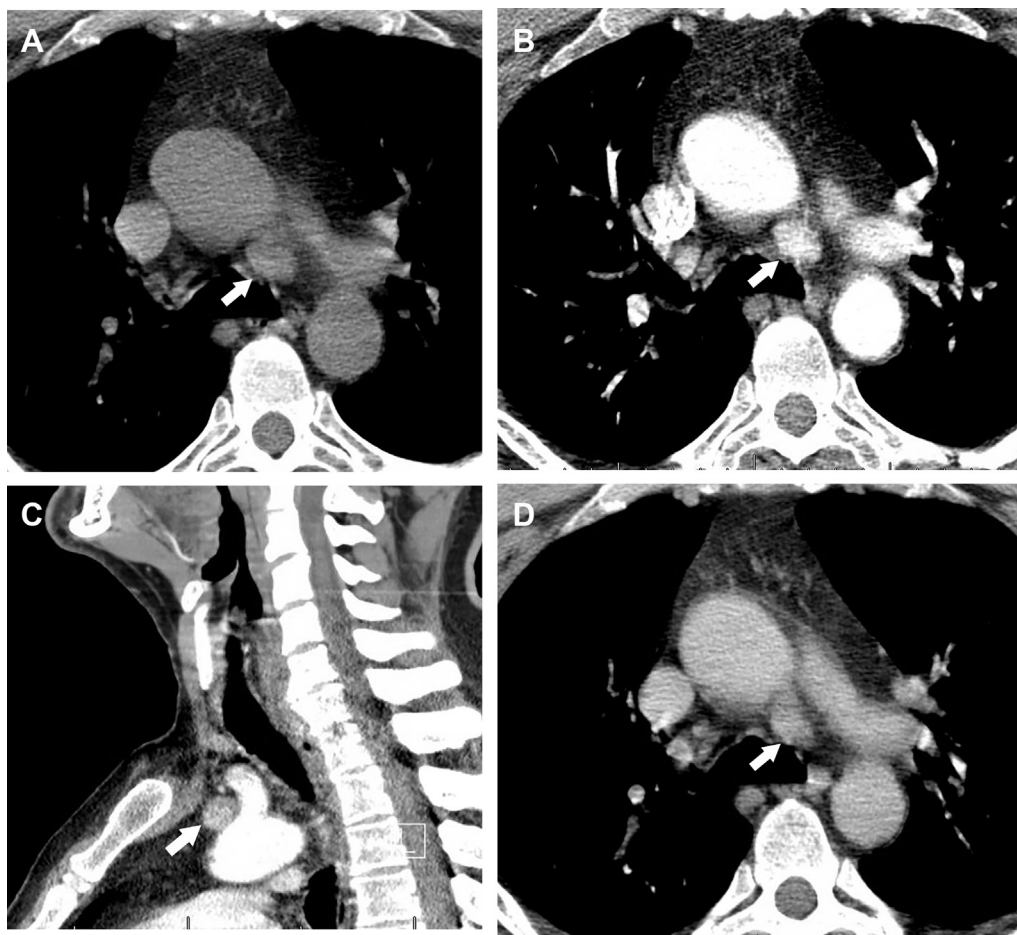
The majority of cases of hyperparathyroidism present during the 5th to the 7th decades of life and common clinical presentations include osteopenia and joint pain, recurrent kidney stones, hypertension, and peptic ulcers [2]. Approximately 88% of cases are caused by solitary parathyroid adenoma. Other less common causes include parathyroid hyperplasia, multigland disease (MGD), and rare carcinoma [2].

Ultrasound, scintigraphy, and 4D CT are commonly used to diagnose parathyroid adenomas [1]. Surgical resection is usually curable in cases of solitary parathyroid adenomas. However, surgical approach for resection of parathyroid

adenoma has greatly changed from the traditional large transverse incision and four-gland cervical exploration to much smaller incisions with the aim of targeted resection of the solitary parathyroid adenoma [3]. The new minimal invasive approach necessitates accurate preoperative localization of the adenoma. 4D CT provides accurate localization of parathyroid adenomas, including ectopic adenomas [1].

The term “4D CT” has various interpretations. The original description by Rodgers et al [4] described the first three “dimensions” as multiplanar CT scan: axial scan with sagittal and coronal reformatted image, while the fourth “dimension” was the change in the perfusion pattern of the adenoma over three phases: noncontrast, arterial, and venous scans. Since that time, different modifications to the original protocol were introduced. This included four phases or scans (a non-enhanced scan and three contrast-enhanced scans), or three or two phases (scans) [5–9]. For this study, we used four scans including noncontrast, arterial, venous, and delayed images. Since that time, we have modified our 4D protocol and use the protocol as described by Hoang et al [1].

4D CT has higher sensitivity for localization of parathyroid adenomas compared to sestamibi imaging, given its higher spatial resolution [1,4]. This allows for accurate preoperative localization of even small adenomas. In their study, Galvin et al [10] highlighted the fact that the smallest lesion detected by scintigraphy was 10 mm versus 4 mm on 4D CT. In addition, the pattern of contrast enhancement of parathyroid adenoma is very characteristic, showing intense enhancement in the arterial phase (peak enhancement between 25 and 60 seconds following contrast injection) with washout of contrast in the delayed phases [1]. This feature in particular can differentiate parathyroid adenoma from its main mimic, lymph node. Lymph nodes show progressive enhancement over time with peak enhancement at 90 seconds [1], corresponding to the venous phase in the 4D CT protocol.



**Fig. 2 – Perfusion pattern of ectopic parathyroid adenoma during 4D CT scan. (A) Precontrast CT scan showing an isodense mass lesion (arrow) at the aortopulmonary window measuring approximately 2 × 1.5 cm in axial dimensions. Arterial phase axial (B) and sagittal (C) images show avid early enhancement of the ectopic parathyroid adenoma. (D) Delayed phase scan shows washout of contrast 85 seconds after contrast administration. 4D, four dimensional.**

While several studies documented higher sensitivity of 4D CT versus ultrasound and scintigraphy for detection of solitary parathyroid adenomas, 4D CT appears to be of particular high importance in patients with MGD [4,10]. MGD represents real challenge for both radiologists and surgeons given the higher incidence of nonlocalizing imaging studies and failed surgeries in this population [10,11]. Rodgers et al [4] found that 4D CT was more accurate than scintigraphy in patients with MGD, with sensitivities of 45% and 9%, respectively. Reasons behind the lower sensitivity of scintigraphy in MGD included its poor spacial resolution, specially for the smaller size adenomas commonly seen in MGD, in addition to the masking effect of retained radiopharmaceutical in the adjacent thyroid or submandibular glands [10].

Based on these facts, scoring systems were proposed for preoperative prediction of MGD. Those patients will definitely need more thorough examination by 4D CT to avoid missing any small adenomas [11]. Composite MGD score was proposed by Sepahdari et al [11]. This scoring system included evaluation of the number and size of the adenomas as identified on 4D CT, in addition to the Wisconsin Index (WIN). The WIN is

the product of serum calcium (milligram/decileter) and PTH levels (picogram/milliliter). It was found that an adenoma size of <7 mm had a specificity of 85% for MGD, whereas sizes of > 13 had a specificity of 85% for single-gland disease [11]. WIN of < 661 showed 90% specificity for MGD, whereas values >1629 were 91% specific for single adenomas. Sepahdari et al [11] concluded that composite MGD scores of  $\geq 4$ ,  $\geq 5$ , and 6 had specificities of 81%, 93%, and 98 %, respectively.

## Conclusion

This case demonstrates the use of multiple imaging modalities for diagnosis and accurate localization of an ectopic parathyroid adenoma. Significantly, the use of 4D CT greatly enhanced preoperative localization. 4D CT has higher sensitivity than scintigraphy for single and MGD [10]. Factors that may limit the sensitivity of 4D CT include MGD, multinodular goiter, and noisy images in patient with large body habitus [10]. Radiologists need to pay special attention to those groups of patients to avoid missing parathyroid adenomas.

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## Acknowledgment

The authors would like to thank Mrs. Yomna A. Morad for her help with the preparation of the figures shown in this case report.

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