Original Article

Prevalence of incidental thyroid abnormalities in patients with degenerative cervical spondylosis: a retrospective cross-sectional magnetic resonance imaging study

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Background: Incidental thyroid abnormalities found on magnetic resonance imaging (MRI) of the neck are not uncommon. This study aimed to investigate the prevalence of incidental thyroid abnormalities in the cervical spine MRI of the degenerative cervical spondylosis (DCS) population indicated for surgery and to identify patients who require additional workup based on the recommendations of the American College of Radiology (ACR).

Methods: All consecutive patients with DCS and indications for cervical spine surgery from October 2014 to May 2019 in the Affiliated Hospital of Xuzhou Medical University were reviewed. All MRI scans of the cervical spine routinely include the thyroid. Cervical spine MRI scans were retrospectively evaluated for the prevalence, size, morphologic characteristics, and location of incidental thyroid abnormalities.

Results: A total of 1,313 patients were included in the analysis, 98 (7.5%) of whom were found to have incidental thyroid abnormalities. The most frequent thyroid abnormality was thyroid nodules (5.3%), followed by goiters (1.4%). Other thyroid abnormalities included Hashimoto thyroiditis (0.4%) and thyroid cancer (0.5%). There was a statistically significant difference in age and sex between patients with DCS with and without incidental thyroid abnormalities (P=0.018 and P=0.007). Stratified by age, the results showed that the highest incidence of incidental thyroid abnormalities was found in patients aged 71 to 80 years (12.4%). Eighteen patients (1.4%) needed further ultrasound (US) and relevant workups.

Conclusions: Incidental thyroid abnormalities are common in cervical MRI, with a prevalence of 7.5% identified in patients with DCS. Incidental thyroid abnormalities are large or have suspicious imaging features, and further evaluation with a dedicated thyroid US examination should be completed before cervical spine surgery is undertaken.

Keywords: Cervical spondylosis; thyroid nodule; incidence; magnetic resonance imaging (MRI)

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Introduction

Degenerative cervical spondylosis (DCS) is a chronic, progressive deterioration of the osseocartilaginous components of the cervical spine (1). Surgical intervention may be indicated if there is significant neurologic dysfunction or progressive instability of the cervical spine. Cervical spine magnetic resonance imaging (MRI) is the preferred imaging technique for assessing patients for DCS because it provides information about osseous, intervertebral disc, and spinal cord structures (2).

Incidental thyroid abnormalities are defined as discrete, nonpalpable lesions radiologically distinct from the surrounding parenchyma that are found on anatomic imaging studies performed for reasons other than a planned assessment of thyroid disease (3-5). The thyroid gland is located near the lower cervical spine, and the detection of incidental thyroid abnormalities on MRI of the cervical spine has been reported (3,4). Incidental thyroid abnormalities are reported to be present on 20–67% of ultrasound (US) examinations and 16% of computed tomography (CT) scans and MRI scans of the neck (3-5). Yoon *et al.* (6) found at least a 9.4% prevalence of malignancy among incidental thyroid abnormalities detected on CT scans. Incidental thyroid abnormalities can be malignant; therefore, the American College of Radiology (ACR) recommends further evaluation with US for patients aged <35 years with nodules measuring ≥1 cm in the axial plane. If the patient is aged ≥35 years, the size for further evaluation is raised to 1.5 cm, and all enlarged thyroid glands should undergo further workup with dedicated US (3). However, to date, few studies have reported the prevalence of incidental thyroid abnormalities focused on MRI, and the prevalence in cervical spine MRI in the literature ranges widely, from 5.1% to 49.6% (7,8). In anterior cervical surgery, vigorous mobilization of the thyroid gland, especially the development of a goiter, may damage the recurrent laryngeal nerve (9). Previous studies also reported anterior cervical discectomy and fusion combined with thyroid gland surgery when a goiter is encountered during cervical surgery (9,10). However, the prevalence of thyroid abnormalities in patients with cervical spondylosis requiring surgery is unclear.

Therefore, the purpose of our study was to evaluate the prevalence of incidental thyroid abnormalities found on cervical spine MRI scans in patients indicated for surgery. Our purpose was also to identify how many patients needed additional workups based on the recommendations of the ACR criteria and to emphasize the clinical significance of incidental thyroid abnormalities. We present the following article in accordance with the STROBE reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-22-484/rc).

Methods

Participants

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics board of the Affiliated Hospital of Xuzhou Medical University, and informed consent was obtained from all individual participants. The prevalence of thyroid nodules was reported to be as high as 36.9% in the normal population who underwent US from 30 provinces and regions in China (11). Since US is more sensitive to the thyroid than is MRI, we set the prevalence of incidental thyroid abnormalities found on cervical spine MRI scans at 25%. Using the proportion of 25% and with 95% confidence to control the permissible error to 10%, the calculated sample size we needed was 1,191. After taking the nonresponse rate of 10%, we determined the final sample size to be 1,310.

The retrospective cross-sectional study consisted of 1,370 patients with end-stage DCS admitted to the Affiliated Hospital of Xuzhou Medical University for cervical spine surgery from October 2014 to May 2019. All patients were diagnosed with at least 1 of the following DCSs: cervical disc herniation, ossification of the posterior longitudinal ligament (OPLL), or cervical spinal stenosis. All patients underwent X-ray and MRI scans of the cervical spine. Exclusion criteria included poor-quality MRI images, such

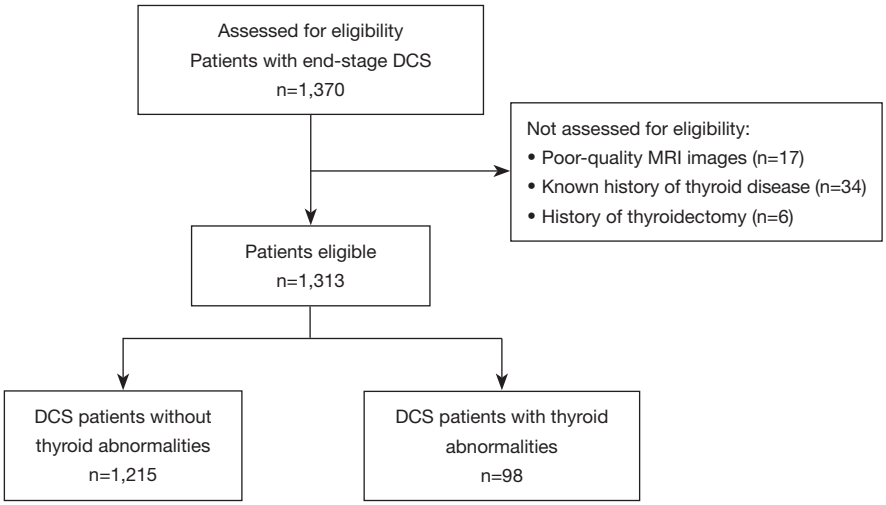

Figure 1 Data flow diagram of the study population. DCS, degenerative cervical spondylosis; MRI, magnetic resonance imaging.

as those with movement artifacts or incomplete images of the thyroid; a known history of thyroid disease; a history of thyroidectomy; and prior evaluation of the thyroid gland, such as a previous thyroid US study or thyroid biopsy. Finally, 1,313 participants were analyzed (*Figure 1*).

Imaging technique and assessment

All MRI scans were performed in a 1.5-Tesla (1.5-T) scanner (Magnetom Symphony 1.5 T, Siemens Healthineers, Erlangen, Germany). Images covering a vertical area ranging from the orbit to the T1 vertebra and a horizontal area ranging from the maxilla to the occiput were obtained. The MRI protocol consisted of the following sequences: T1-weighted turbo spin-echo imaging [repetition time (TR)/time to echo (TE) 620/9, matrix 320×224, field of view (FOV) 20 cm × 18 cm, parallel imaging factor 1.5, section thickness 4 mm with a 1-mm intersection gap, and acquisition time 36 sections for 2 minutes], T2-weighted turbo spin-echo imaging (TR/TE 4,102/90, matrix 320×224; section thickness 4 mm with a 1-mm intersection gap, and acquisition time 36 sections for 3 minutes), and diffusion-weighted single-shot turbo spin-echo echo-planar imaging (TR/TE 4,968/72, parallel imaging factor 1.8, b factors 0 and 1,000 s/mm^2, FOV 40 cm ×28 cm, image matrix 160×128 reconstruction, section thickness 4 mm with a 1-mm intersection gap, and acquisition time 36 sections for 2 minutes).

The T1- and T2-weighted sagittal and axial cervical spine images were retrospectively evaluated by 2 board-certified radiologists specializing in the spine. All thyroid abnormalities in cervical MRI were retrospectively evaluated by 2 consultant head and neck radiologists, both of consultant and radiologists were blinded to the patients' medical histories. Disagreement was resolved by consensus. Patient characteristics of age, sex, body mass index (BMI), and smoking history, and nodular characteristics, such as nodule size, nodule laterality, and morphologic features (diffuse, focal, or multifocal), were recorded. The laterality of the thyroid nodule was divided into the right lobe, isthmus, and left lobe. The study population was divided into 2 groups according to the combination of thyroid abnormalities.

For thyroid abnormalities in patients found on MRI scans, the diagnosis was clarified by reviewing the relevant US scans, pathologic results, blood chemistry, and other relevant workups. For patients without a relevant workup, 2 consultant head-and-neck radiologists diagnosed thyroid nodules or goiters based on MRI features.

Data analysis

Patients were divided into 2 groups according to whether they had thyroid abnormalities. Group A consisted of patients with DCS and without thyroid abnormalities, while group B consisted of patients with DCS and with thyroid abnormalities. For quantitative data, continuous variables with a normal distribution are expressed as the mean ± standard deviation (SD) and were compared using the Mann-Whitney test between the 2 groups. The chi-squared

Table 1 Preoperative patient demographics

Patient characteristics	Group A (n=1,215)	Group B (n=98)	P value
Age, mean (SD), years	55.4 (11.3)	58.4 (11.5)	0.018*
Women, n (%)	571 (47.0)	76 (77.6)	0.007*
BMI, mean (SD), kg/m^2	24.4 (3.2)	24.9 (3.6)	0.619
Smokers, n (%)	13 (1.1)	6 (0.6)	0.199

*, P<0.05. BMI, body mass index; SD, standard deviation.

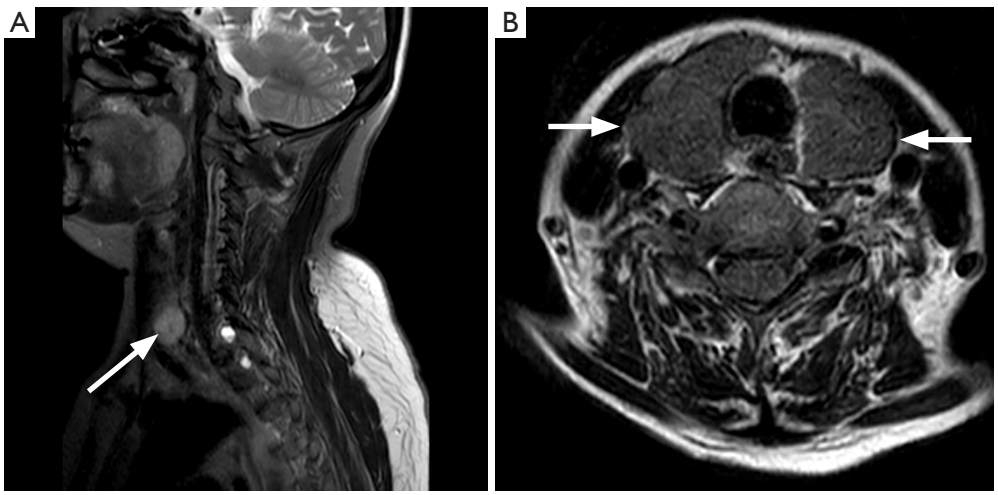

Figure 2 MR images of thyroid abnormalities. The sagittal T2-weighted image (A) shows an oval and well-defined hyperintense thyroid mass (white arrow). The axial T2-weighted image (B) shows bilateral diffuse enlargement of the thyroid gland (white arrows). MR, magnetic resonance.

test was used to find associations between different sets of categorical data. All statistical tests were completed using SPSS 25.0 (IBM Corp, Armonk, NY, USA). A P value less than 0.05 was considered statistically significant.

Results

A total of 1,313 patients (666 males and 647 females) who met the inclusion criteria and had a mean age of 55.5 years (range, 28–93 years) were surveyed. There were no significant differences in BMI or smoking history between groups A and B (*Table 1*).

Of the 1,313 patients, 98 patients (7.5%) had incidental thyroid abnormalities on cervical spine MRI scans. Of the thyroid abnormalities, 76 patients (77.6%) were female and 22 patients (22.4%) were male, showing a female predominance in the incidence of thyroid abnormalities. Compared to group A, group B showed a significantly higher proportion of females (P=0.007). The most common thyroid abnormality was thyroid nodules (69/1,313, 5.3%), followed by goiters (18/1,313, 1.4%), Hashimoto thyroiditis (5/1,313, 0.4%), and thyroid cancer (6/1,313, 0.5%; *Figure 2*).

Regarding age, results showed that the prevalence of incidental thyroid abnormalities was the highest in patients in the 71- to 80-year age group (12.4%, 17/137), followed by those in the 61- to 70-year age group (7.3%, 24/328), those in the 51- to 60-year age group (7.1%, 34/479), those in the 41- to 50-year age group (6.2%, 16/259), and those in the 31- to 40-year age group (5.6%, 5/90). One case of incidental thyroid abnormalities was found in the 21- to 30-year age group. The prevalence of incidental thyroid abnormalities increased with age. The distribution of incidental thyroid abnormalities stratified by age is shown in *Figure 3*.

Single incidental thyroid abnormalities were detected

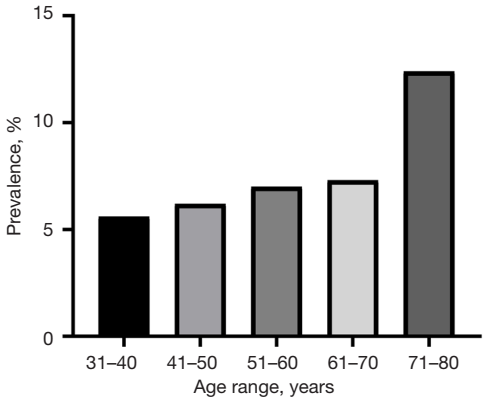

Figure 3 The prevalence of incidental thyroid abnormalities in different age groups.

Table 2 The distribution of incidental thyroid abnormalities

Nodule characteristic	Value
Diameter, n (%)	
<5 mm	24 (24.5)
5–10 mm	34 (34.7)
>10 mm	40 (40.8)
Maximum diameter of the largest nodule, mean (SD), mm	9.0 (4.2)
Multiple nodules, n (%)	26 (26.5)
Nodule laterality, n (%)	
Unilateral abnormality	73 (74.5)
Bilateral abnormality	25 (25.5)
Lesion features, n (%)	
Diffuse	19 (19.4)
Focal	60 (61.2)
Multifocal	19 (19.4)

SD, standard deviation.

in 73 patients (74.5%), and the remaining 25 patients (25.5%) had multiple thyroid nodules. The average size of the largest thyroid nodules was 9 mm (SD 4.2 mm; range, 3–32 mm). The longest diameter of the dominant nodule was ≤10 mm in 58 (59.2%) patients, and 40 (40.8%) patients had lesions larger than 10 mm. The internal structure of the dominant nodules is shown in *Table 2*. In addition, a review of the surgical records, specifically the description of the operation time and procedure, indicated that no apparent surgical difficulties due to thyroid disease were encountered.

Among patients younger than 35 years old, 2 patients had incidental thyroid abnormalities larger than 10 mm. Of the patients older than 35 years old, 20 patients had thyroid nodules larger than 15 mm. In addition to the 18 patients with goiters. Forty patients older than 35 years were recommended to undergo further US examination based on the ACR criteria (*Table 3*). Of the 98 patients with thyroid abnormalities, US was performed in 27 patients. Among these 27 patients, 22 met the ACR criteria, and 5 did not meet the ACR criteria but still completed the US examination. In addition, 5 patients were diagnosed with Hashimoto thyroiditis by US and hematologic indices. The other 6 cases of thyroid cancers were diagnosed with postoperative pathology. None of the patients had suspicious features found in the thyroid region.

Discussion

This study quantitatively assessed the prevalence of incidental thyroid abnormalities on cervical MRI in a DCS population indicated for surgical intervention. In our study, 98 patients (7.5%) were observed to have incidental thyroid abnormalities as shown by cervical spine MRI. Both adenomatous goiters and papillary thyroid cancer were also found in our study population. Most patients with these incidental thyroid abnormalities did not undergo further

Table 3 Follow-up results of 40 patients who needed further ultrasound examination based on the ACR criteria

Thyroid abnormality	Age (years)	Size (mm)	Number (n=40)	US (n=22)	FNAC (n=2)	Surgery (n=6)	Final diagnosis [number]
Thyroid nodule	<35	≥1 mm	2	1	0	1	Thyroid cancer [1]; thyroid nodule [1]
	≥35	≥1.5 mm	20	16	2	4	Hashimoto's thyroiditis [4]; thyroid cancer [4]; thyroid nodule [12]
Goiter	–	–	18	5	0	1	Multinodular goiter [1]; goiter [17]

ACR, American College of Radiology; US, ultrasound; FNAC, fine needle aspiration cytology.

evaluation. According to the ACR guidelines, 59.2% of incidental thyroid abnormalities (n=58) have a small size and a low risk of malignancy. These findings underscore the need to pay special attention to incidental thyroid abnormalities on cervical MRI scans in patients with DCS.

The most frequently observed incidental extraspinal pathologies on cervical spinal MRI scans are thyroid nodules, which might be an anatomical risk factor for traction injury during anterior cervical surgery (3,12). Surgical intervention may be required for persistent or progressive symptoms of DCS. Nevertheless, Gulsen *et al.* (9) reported that it is extremely difficult to expose the prevertebral region when localized lesions or anatomical variants, such as enlarged thyroid tissue, are encountered. Forceful medial retraction of the enlarged thyroid to reach the anterior part of the vertebrae and intervertebral discs can lead to injuries to the anterior neck structures and recurrent laryngeal nerve injury. Patients who undergo repeated cervical operations, those with an enlarged thyroid, or those who have undergone thyroid surgery have a higher risk of recurrent laryngeal nerve injury (13,14).

MRI is widely used to assess patients for cervical diseases; therefore, the observed prevalence of incidental thyroid abnormalities has increased (15). In a survey of 30 provinces and regions in China, the prevalence of thyroid nodules was reported to be as high as 36.9% in the normal population who underwent US (11). Kim *et al.* (8) reported that the prevalence of incidental thyroid abnormalities on cervical spine MRI scans was 5.1% in their 389 participants. However, the population in their study included patients who underwent cervical spine MRI for any reason. In the present study, in our series of patients with DCS patients and with indications for surgery, incidental thyroid abnormalities were found in 7.5% of these patients. However, Özdemir *et al.* (7) reported a prevalence of 49.6% for incidental thyroid abnormalities by evaluating 512 cervical spinal MRI scans, which was much higher than the prevalence observed in our study. To understand these variations, we need to consider the large differences in several characteristics of the study population, such as age, sex, and inclusion criteria.

Despite its sensitivity in identifying malignant nodules, positron emission tomography CT (PET-CT) can only detect 8.4% of incidental thyroid nodules, compared to 10.4% of incidental thyroid nodules on MRI (11,16). Moreover, there are no features associated with incidental thyroid nodules on CT and routine MRI scans to reliably identify malignant lesions (11,16-18). Multiple studies have demonstrated that compared with clinically detected thyroid nodules, incidental thyroid abnormalities are associated with less aggressive features, reduced recurrence, and longer progression-free survival (19,20). However, there is still at least a 9.4% prevalence of malignant or potentially malignant lesions among incidental thyroid abnormalities detected on CT scans (6). Therefore, further evaluation is warranted to identify the nature of incidental thyroid lesions. The discovery of thyroid abnormalities is also a psychological and financial burden for patients. If thyroid abnormalities in patients can be detected early via completion of the relevant thyroid workup before patients undergo cervical spine surgery, a general surgeon experienced in thyroid surgery should be consulted to determine whether incidental thyroid abnormalities need surgery and to specify the relevant surgical plan if needed (e.g., anterior cervical discectomy and fusion combined with thyroid gland surgery). Consequently, reducing unnecessary testing and instead taking a more individualized and evidence-based approach would be favorable for patients and the health care system.

Different from the ACR, the American Thyroid Association recommends that US should be used to evaluate all incidental thyroid nodules (21,22). However, an ACR white paper published in 2015 provides workup recommendations for thyroid nodules incidentally detected on radiographic imaging (3). In addition to incidental thyroid nodules that are accompanied by suspicious imaging features (i.e., suspicious lymph nodes, local invasion, PET-avid nodules), regardless of nodule size or patient age, the ACR recommends that all patients with incidental thyroid nodules and suspicious features undergo US to confirm the findings, with consideration for fine needle aspiration (FNA). In otherwise healthy patients without suspicious imaging features, the ACR recommends US for nodules meeting a minimum size threshold of 1 cm in patients younger than 35 years and 1.5 cm in patients 35 years and older (3,23,24). Based on the ACR criteria, a total of 40 patients (40.8%) in our study needed further US and relevant workups. However, 1 case of thyroiditis and 1 case of thyroid cancer would have been missed by adhering to the ACR criteria. Some meaningful lesions might still have been missed because not all patients underwent thyroid US, but this omission rate is within the acceptable range.

There were several limitations in this study. First, we used a retrospective cross-sectional design to examine the MRI scans of patients with DCS. We did not evaluate the MRI features of incidental thyroid abnormalities

on cervical MRI studies for possible association with malignancy. However, we analyzed patients who needed further workup according to the ACR guidelines. Second, some patients might have undergone surgical treatment for thyroid disease after MRI or US despite having cervical spondylosis requiring surgical treatment. This situation might have had an impact on the calculated prevalence. Third, DCS is an overarching term to describe various degenerative conditions of the cervical spine, including cervical spondylotic myelopathy, OPLL, and degenerative disc disease. The above-mentioned diseases are often concomitant with DCS. For example, in several patients with DCS, cervical disc herniation was usually concomitant with OPLL or cervical spinal stenosis (25). Therefore, we did not split DCS into different diagnoses, such as disc herniation or OPLL ossification. Instead, we compared the distribution of incidental thyroid nodules among groups. Fourth, our study population mainly comprised patients in the 50- to 60-year age group. Finally, due to the limitations of race, population, living habits, etc., findings from this study may not be applicable to other regions.

Conclusions

Incidental thyroid abnormalities identified during cervical MRI may contain clinically significant lesions and warrant follow-up evaluation when identified. In our population, 7.5% had incidental thyroid abnormalities, and a total of 40 patients (40.8%) needed further US and relevant workup based on the ACR criteria. Incidental thyroid abnormalities that are large or have suspicious imaging features may alter the patient's treatment or affect the patient's life. Further evaluation with a dedicated thyroid US examination should be completed before the patient is indicated for cervical spine surgery.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-22-484/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-22-484/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics board of the Affiliated Hospital of Xuzhou Medical University , and informed consent was obtained from all individual participants.

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