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Pilot study of ultrasound parotid imaging reporting and data system (PIRADS): Inter-observer agreement

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ABSTRACT

Aim: To establish proposal ultrasound parotid imaging reporting and data system (PIRADS) for classification and prediction of malignancy of parotid lesions and to assess the inter-observer agreement of this system.

Subjects and methods: Retrospective analysis of ultrasound and power Duplex images of 142 patients with parotid lesions by two reviewers. Parotid focal lesions were classified into nine patterns and then categorized into five groups: PIRADS 1, definitively benign; PIRADS 2, probably benign; PIRADS 3, indeterminate; PIRADS 4, probably malignant; and PIRADS 5, highly suggestive malignant.

The results: There was excellent interobserver agreement of both reviewers for patterns and PIRADS ($K = 0.84$, $P = 0.001$) with 92% percent agreement. There was excellent agreement of PIRADS 1 ($K = 1.00$, $P = 0.001$), PIRADS 2 ($K = 0.97$, $P = 0.001$), PIRADS 3 ($K = 0.86$, $P = 0.001$) and PIRADS 5 ($K = 0.88$, $P = 0.001$) and good agreement of PIRADS 4 ($K = 0.67$, $P = 0.001$). The Odds ratio of PIRADS 3, 4 and 5 were 1.36 (95% $CI = 0.39$–4.55), 7.11 (95% $CI = 3.02$–11.15) and 8.27 (95% $CI = 3.49$–10.27) respectively. The accuracy was 92% and 90%, sensitivity was 79% and 65%, specificity was 94% and 96% of PIRADS of both reviewers respectively.

Conclusion: The proposed PIRADS is a reliable non-invasive imaging modality that can be used for categorizing parotid lesions and prediction of malignancy.

1. Introduction

Parotid lesions represent a spectrum of benign, infectious, autoimmune, and malignancy. Differentiation of parotid malignant from benign focal lesions is important for treatment planning and prognosis [1–7]. Different MR pulse sequences as diffusion-weighted MR imaging, dynamic contrast MR imaging, dynamic-susceptibility contrast perfusion-weighted MR imaging and MR spectroscopy were used for differentiating malignant from benign parotid lesions. However, their results are overlapping and MR imaging is expensive and time-consuming [8–11]. Delayed contrast CT and perfusion CT of the parotid gland are of limited value and associated with radiation exposure and hazards of intravenous contrast reaction [12–13].

Ultrasound is a useful method for detection and characterization of parotid lesions [14–18]. Despite progress in the diagnostic capability of ultrasound such as ultrasound elastography [19–22] and contrast ultrasound [23], there is overlap between sonographic features of benign and malignant parotid lesions [18]. This poses a challenge for radiologists to classify the parotid lesions and to predict malignancy. Reports describing sonographic findings are sometimes confusing and there is problem in transmission of findings from radiologists to the clinicians [14–18].

Due to the subjective nature of the examiner's impression, there is a need for a standardized nomenclature and definition for features of the parotid lesions evaluated by ultrasound. At present, there is no standard sonographic lexicon for interpreting ultrasound images of the parotid lesions [2–6]. There are several reporting systems, such as Breast Imaging Reporting and Data System (BIRADS) for evaluating breast lesions [24,25]. Similar to BIRADS, the developed thyroid imaging reporting and data system

Abbreviations: BIRADS, breast imaging reporting and data system; GI-RADS, gynecological imaging reporting and data system; PIRADS, parotid imaging reporting and data system; TIRADS, thyroid imaging reporting and data system.

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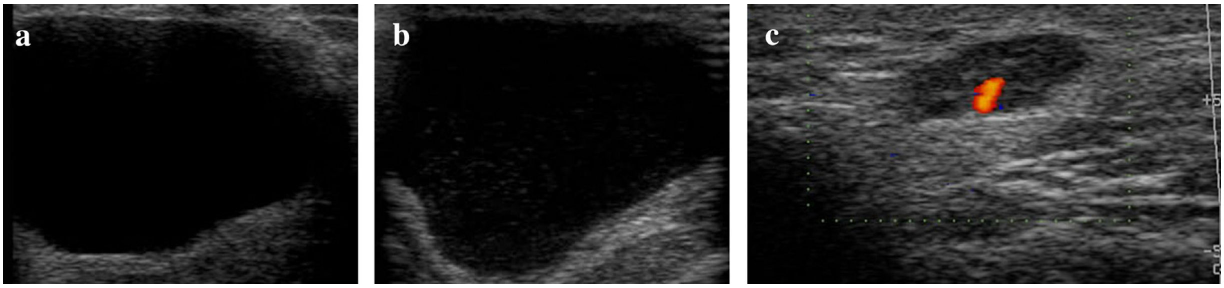

Fig. 1. PIRADS 1: (A) Pattern one (simple cyst pattern): ultrasound of the parotid gland shows well-defined thin walled cyst with no echoes inside. **(**B) Pattern two (abscess pattern): ultrasound of the parotid gland shows well-defined thick walled cystic lesion with fine and coarse echoes. (C) Pattern three (nodal pattern): Ultrasound of the parotid gland shows oblong intra-parotid reactive lymph node with hyperechogenic hilum and central flow with power Duplex examination.

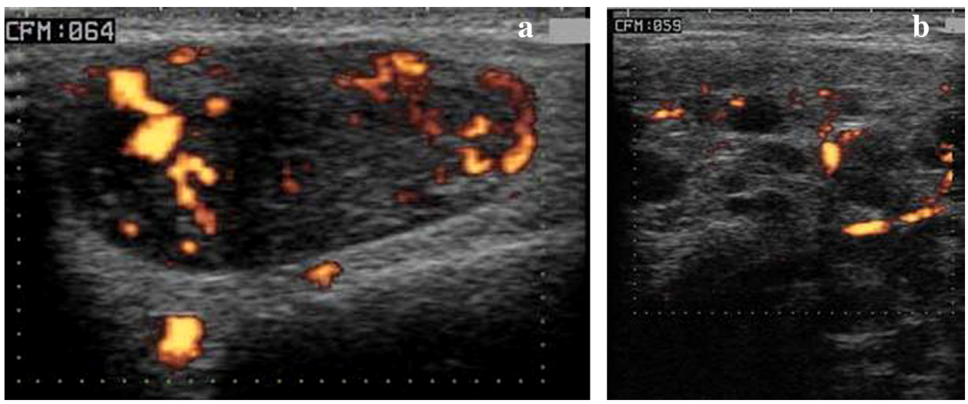

Fig. 2. PIRADS 2: (A) Pattern four (benign unifocal pattern): ultrasound of the parotid gland shows well-defined oval focal lesion with homogeneous echo pattern and vascularity at power Duplex. (B) Pattern five (multifocal pattern): Ultrasound of the parotid gland shows multiple rounded, well defined scattered focal lesions within parotid parenchymal in patient with Sjögren's syndrome.

(TIRADS) is used in risk stratification of thyroid nodules [26–30] and gynecological imaging and reporting data system GI-RADS were recently introduced to categorize the adnexial masses [31].

The aim of this work is to establish a proposal ultrasound parotid imaging reporting and data system (PIRADS) for for classification and prediction of malignancy of parotid lesions and to assess the inter-observer agreement of this system.

2. Material and methods

2.1. Patients

The study was approved by the institutional review board and informed consent from the patients was waived because this is a retrospective study. The inclusion criteria were consecutive patients with unifocal and multifocal parotid lesions that underwent ultrasound and power duplex examination in the period from 2006 to 2014. We excluded 27 patients from the study because the biopsy was not done in 20 patients and unsuccessful fine needle biopsy results in 7 patients. The study included 142 patients (101 female and 41 male; age range from 18 to 67 years) with parotid lesions and diagnosis was made by ultrasound and confirmed with fine needle biopsy. The final diagnosis of parotid lesions was benign lesions ($n = 122$) and malignant tumors ($n = 20$).

2.2. Ultrasound technique

Ultrasound examination was performed using high-resolution machine (AU 5; ESAOTE, Genoa, Italy) with a 10–18 MHz linear high-resolution transducer. The scanning protocol was both transverse and longitudinal real-time ultrasound imaging of the parotid focal lesions, and power Doppler imaging. The images were archived at Digital Imaging and Communications in Medicine images (DICOM).

2.3. Image analysis

Analysis of ultrasound and power Doppler images was performed by 2 radiologists (AA and AG) who are expert in ultrasound of head and neck imaging for more than 25 and 10 years respectively who were blinded to the clinical presentation and findings and pathological results. First, both reviewers reviewed the still images of the parotid lesions at conventional B mode-ultrasound and power Duplex ultrasound and developed the classification system of parotid lesions. The lesions were characterized according to the internal component (solid, mixed or cystic), the shape (round, oblong), the margin (well-defined, fairly-defined or ill-defined), the echogenicity and vascularity. Echogenicity of the lesion was classified as hyperechoic, hypoechoic or anechoic in relation to the adjacent healthy parotid gland or contralateral parotid gland. The vascularity of the lesion was classified as avascular (no vessel within the mass), mild (less than 5 vessel segments within the mass) and marked vascularity (more than 5 vessel segment within the mass). We established nine patterns of parotid lesions (Table 1) guided by previous studies published in the ultrasound criteria of different parotid lesions [10–18]. The defined ultrasound patterns were pattern one (Simple cyst pattern), pattern two (Abscess), pattern three (Nodal pattern), pattern four (Unifocal benign pattern), pattern five (Multifocal pattern), pattern six (Simple neoplastic pattern), pattern seven (Complex cystic pattern), pattern eight (Malignant pattern A) and pattern nine (Malignant pattern B). These patterns categorized according to the new PIRADS into: PIRADS 1 (Definitively benign) (Fig. 1) included pattern 1, 2 and 3; PIRADS 2 (Probably benign) (Fig. 2) included pattern 4 and 5; PIRADS 3