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Computed Tomography / Tomodensitométrie

Out of Hours Emergency Computed Tomography Brain Studies: Comparison of Standard 3 Megapixel Diagnostic Workstation Monitors With the iPad 2

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Abstract

Purpose: The purpose was to compare performance of diagnostic workstation monitors and the Apple iPad 2 (Cupertino, CA) in interpretation of emergency computed tomography (CT) brain studies.
Methods: Two experienced radiologists interpreted 100 random emergency CT brain studies on both on-site diagnostic workstation monitors and the iPad 2 via remote access. The radiologists were blinded to patient clinical details and to each other's interpretation and the study list was randomized between interpretations on different modalities. Interobserver agreement between radiologists and intraobserver agreement between modalities was determined and Cohen kappa coefficients calculated for each. Performance with regards to urgent and nonurgent abnormalities was assessed separately.
Results: There was substantial intraobserver agreement of both radiologists between the modalities with overall calculated kappa values of 0.959 and 0.940 in detecting acute abnormalities and perfect agreement with regards to hemorrhage. Intraobserver agreement kappa values were 0.939 and 0.860 for nonurgent abnormalities. Interobserver agreement between the 2 radiologists for both diagnostic monitors and the iPad 2 was also substantial ranging from 0.821-0.860.
Conclusions: The iPad 2 is a reliable modality in the interpretation of CT brain studies in them emergency setting and for the detection of acute and chronic abnormalities, with comparable performance to standard diagnostic workstation monitors.

Résumé

Objectif : L'étude avait pour objectif de comparer la performance des écrans des postes de travail diagnostique à celle des écrans des iPad 2 d'Apple (Cupertino, Californie, États-Unis) lors de l'interprétation d'examens par tomodensitométrie (TDM) du cerveau réalisés d'urgence.
Méthodes : Cent examens par TDM du cerveau (réalisés d'urgence et sélectionnés de façon aléatoire) ont été interprétés par deux radiologistes chevronnés, sur place à l'aide d'un poste de travail diagnostique et à distance à l'aide d'un iPad 2. Les radiologistes ont effectué leur interprétation à l'aveugle, c'est-à-dire sans connaître les renseignements cliniques du patient ni les conclusions de leur collègue. La liste d'étude intégrait de façon aléatoire l'interprétation des examens selon l'une ou l'autre des modalités. Le degré de concordance inter-observateur (entre les radiologistes) et de concordance intra-observateur (entre les modalités d'interprétation) a été déterminé, et les coefficients kappa de Cohen ont été calculés. La performance en matière d'anomalies urgentes et non urgentes a été évaluée séparément.
Résultats : Les deux radiologistes ont affiché un degré de concordance intra-observateur élevé. Ils ont obtenu des valeurs kappa globales de 0,959 et 0,940 pour la détection des anomalies aiguës, un degré de concordance parfait pour les hémorragies et des valeurs kappa de 0,939 et de 0,860 pour les anomalies non urgentes. Les radiologistes ont également affiché un degré de concordance inter-observateur élevé pour

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ce qui est de l'interprétation des résultats au poste de travail diagnostique et à l'écran du iPad 2: ils ont obtenu des valeurs kappa allant de 0,821 à 0,860.

Conclusions : L'iPad 2 constitue une modalité fiable pour interpréter les examens par TDM du cerveau dans un contexte d'urgence et pour détecter les anomalies aiguës et chroniques. Il offre une performance comparable à celle de l'écran d'un poste de travail diagnostique standard.

Key Words: iPad 2; Computed tomography brain; Emergencies; Picture archiving and communication system

Computed tomography (CT) of the brain is one of the most frequently ordered imaging investigations in the emergency setting, with clinical indications including acute stroke, hemorrhage, and being part of trauma investigation. The timely acquisition and interpretation of images is important in facilitating rapid decision making regarding patient care in the emergency setting. Out-of-hours studies are usually ordered by emergency department physicians and interpreted by the on-call radiologist, either a resident in training, or consultant. The images are usually viewed on site. With the ubiquity of tablet devices, many with high resolution screens, we consider their utility in interpreting CT brain studies via remote access and compare them to standard dedicated on-site picture archiving and communication system (PACS) workstations.

Methods

Study Design

A retrospective review of 100 CT brain studies acquired out of hours (between 6 PM and 7 AM) was performed by 2 experienced CT radiologists (named RadOne and RadTwo), on both on-site PACS workstations and our tablet device of choice, the Apple iPad 2 (Cupertino, CA), via remote access. The studies were chosen at random from a list of out-of-hours studies performed in the last 6 months. The 2 radiologists were blinded to clinical and patient details and to each other's interpretation. The study list was also randomized between interpretation on PACS monitors and the iPad 2. The primary aim of the study was to compare the performance of the iPad 2 with an on-site workstation in detecting urgent abnormalities in out-of-hours CT brain studies. Results were divided into urgent or critical findings and other nonurgent abnormalities (Table 1). Intraobserver agreement of each of the 2 radiologists between their PACS and iPad 2 interpretations and modality-specific intraobserver agreement was calculated and kappa determined for each.

Table 1
Abnormalities recorded in the study

Urgent or critical abnormalities	Nonurgent abnormalities
Acute or chronic hemorrhage	Lacunar infarction, established territorial infarct
Acute infarction (lacunar, territorial)	Periventricular deep white matter hypoattenuation
Other (eg, fractures)	Congenital abnormalities

Imaging Protocol

All studies were acquired on a 64-detector row scanner (Aquilon; Toshiba, Tustin, CA). No intravenous contrast was administered. All studies had multiplanar reconstructions with all axial, sagittal, and coronal images available to view remotely on the iPad 2.

Modality Technical Specifications

The technical specifications of the displays of the PACS workstation monitor (Siemens SMD 21302; Siemens, Erlangen, Germany) and the Apple iPad 2 were noted prior to commencing the study. The diagnostic monitor had a superior resolution, 3 megapixels compared to the display on the iPad 2, which had an approximate resolution of 1.6 megapixels. However, the iPad's contrast ratio was higher than that of the PACS monitor (800:1 vs 700:1) and the image quality was felt to adequate for image interpretation. The rest of the technical specifications are listed in Table 2.

Image Viewing and Interpretation Environment

Image quality on the iPad 2 for interpreting CT brain studies was adequate, in terms of screen resolution, contrast ratio, and luminance. While the maximum luminance of the workstation monitors was 800 cd/m^2, the calibrated value was 480 cd/m^2, similar to the iPad 2. Software used was SYNGO version 10 (Siemens), similar to the one used on workstation, but a mobile version allowing full uncompressed Digital Imaging and Communications in Medicine (DICOM) image viewing.

Table 2
Technical specifications of PACS monitors and iPad 2

Technical specifications	PACS monitor	iPad 2 (Apple, Cupertino, CA)
Resolution	2048 × 1536	1048 × 1536
Display area (W × H), mm	318 × 424	148 × 199
Contrast ratio	700:1	800:1
Luminance	800 cd/m^2	410 cd/m^2
Colour	Greyscale, 1534 shades	Colour, 24-bit

PACS = picture archiving and communication system.