Cardiac imaging: a new iPad medical application

The computing power and ease of use of handheld devices such as modern mobile phones and tablet computers have resulted in their widespread acceptance in many fields. Literally thousands of software applications are available.

In the medical imaging sector also, tablets are increasingly being used satisfactorily in several areas.

This article describes the use of an iPad app for cardiac imaging. Comparative studies show that there is a high correlation between the iPad data and those generated on a dedicated work station.

The rapid and continuous advances and developments in the field of mobile device technology, together with the development of a large number of novel applications for handheld devices, as well as the increase in broadband options, are together constantly decreasing the gap between real and "virtual" radiology imaging interpretation.

Recently released tablet computers such as the iPad from Apple Inc and the Galaxy range from Samsung, are fully functioning standalone computers roughly the size of a thin LCD monitor. They use a LED-backlit touchscreen interface for control and data input. The most recent iPad release (iPad 3rd generation) has a screen size of 25 cm (9.7 in). Such devices incorporate many technological improvements. For example the screen features high motor spatial and contrast resolution (2048×1536; 3.1megapixel), 170° viewing angle, enhanced internet connectivity, rapid data transfer and improved processor power and speed. Compared to laptop computers, tablets have a long battery life and are extremely lightweight and easily portable.

A recent analysis was carried out of handheld display devices from the point of view of the suitability of the image quality characteristics for use in medical imaging [1]. These larger-screen portable devices have been quickly adopted in radiological image interpretation particularly since they enable web-based transfer of images from Picture Archival and Communication Systems (PACS). Many tablet computer applications and viewers that are compatible with Digital Imaging and Communications in Medicine (DICOM) standards are now becoming generally available.

The Authors
Ifat Lavi¹ Ph.D., Guy Malki¹ M.Sc., Prof Ran Komowski¹–² M.D.
1. Department of Cardiology, Institute of Interventional Cardiology, Rabin Medical Center, Beilinson Campus, Petach Tikva, Israel
2. Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel email: ifat.lavi@gmail.com

The benefits of the iPad system for patient-physician interaction in a clinical setting include enhanced and effective face-to-face communication with patients, since the system offers the opportunity to accurately present and explain the nature of the cardiovascular disease, both prior to and after the cardiac intervention.
A comprehensive list of iPad apps for diagnostic reading can be found in the review by Székeley A, et al. [2]. Many other studies have confirmed that they are reliable platforms for viewing computed tomography (CT) images and establishing medical diagnoses, [3,4,5,6,7]. McLaughlin et al. demonstrated that on the iPad there was a 93% diagnostic agreement in the interpretation of CT scans of the brain between general radiologists and neuroradiologists. A few studies have also compared interpretations of magnetic resonance imaging (MRI) examinations of the spine [3,8] using the iPad with diagnostic reports generated on dedicated PACS workstations. It was found that there were high levels of concordance.

Other studies that have been carried out have sought to determine the accuracy of interpretations using the iPad in a variety of disease processes such as tuberculosis and pulmonary nodules in chest radiography. These interpretations were compared to those generated on LCD monitors. It was found that there were high levels of diagnostic agreement in [9,10].

In addition to this, it has been shown that evidence-based decision support apps can be successfully used, for example to choose the most appropriate examination type based on relevant history, to establish initial diagnosis or to identify key symptoms. Other apps also exist to enable clinicians, radiologists and technicians who are following the ALARA (as low as reasonably attainable) principles of appropriate dose to avoid unnecessary diagnostic procedures and to reduce patient radiation exposure. A comprehensive list of decision support apps also appear in the review by Yamazaki et al [1].

Recent studies have even described surgical procedures performed with the assistance of three dimensional (3D) image CT navigation using intraoperative use of an iPad tablet. In these studies 3D images reconstructed prior to the surgery with DICOM image viewing software were generated and transferred to the iPad tablet for interactive reviewing, analysis and manipulation during surgery so as to guide the operative approach [11,12].

**THE IPAD IN CARDIAC CATHETERIZATION AND ECHO LABORATORIES**

We recently published our experience of a dedicated cardiac imaging iPad application with a web-based connection to the PACS systems for online access of relevant data during cardiac catheterization or echocardiography procedures [13].

The iPad allows quick access to all pertinent data such as previous diagnoses, medical records and real-time reports. Full documentation of the procedure is directly downloaded to the physician's iPad giving unlimited options anywhere, and at any time, to review the clinical findings, and to perform measurements directly on the device screen and produce reports. This comprehensive, timely, and reliable collection of patient and clinical data can improve workflow in that the retrieval of data is faster and more efficient. This reduces redundancy, enabling physician mobility and helping to speed up work processes, while also enabling medical staff from different departments to share, consult, review cases, to propose further treatments and to aid in an effective patient follow-up, which altogether improves overall patient care.

The structural benefits of the iPads over desktop and laptop systems lie in the fact that they are tactile-oriented with a touch screen functionality that enables easier use, navigation and coordination than clicking and checking options or using the keyboard and the mouse, replicating the familiarity of the paper interface.

The iPad is also an excellent platform for the presentation of images, videos and animations. A properly calibrated device screen ensures that images can be seen correctly. The benefits of the system for patient-physician interaction in a clinical setting include enhanced and effective face-to-face communication with patients, improved patient education, and higher patient satisfaction since the system offers the opportunity to accurately present and explain the nature of the cardiovascular disease, both prior to and after the cardiac intervention. Efficient usage of this mobile technology enables the clinical condition, catheterization procedure or the echocardiography diagnostic data and potential treatment options to all be presented visually in a clear and professional manner.

**METHOD AND RESULTS**

We previously reported our experience using a novel iPad application for measurement (i.e. length, area and angle) and estimation of the morphology of the anatomical structure analyzed in angiography and echocardiography data sets [13].

We aimed to assess the accuracy and reproducibility of the iPad measurements compared to reports produced on the McKesson workstation which serves as the gold-standard and is routinely used in our hospital.

This novel advanced application has been developed in our Interventional Cardiology Institute in conjunction with

SenoClaire® 3D Breast Tomosynthesis

With GE SenoClaire, powered by ASiRDBT a single MLO view provides clinical non-inferiority compared to 2-view digital mammography—at half the dose and with just one compression. That means SenoClaire has the potential to replace digital mammography exams in screening to help you detect breast cancer.

SenoClaire delivers superior sensitivity for architectural distortions and masses, improves specificity of lesion margin visibility, and helps you better characterize malignant and benign findings. In addition, SenoClaire images are compatible with major PACS systems, so you can integrate them easily into your environment to get the most from your investment.

SenoClaire. Enhancing your clinical confidence—with the same dose as digital mammography of the same view.

To learn more, www.gehealthcare.com/senoclaire

SenoClaire is not FDA approved. It is not yet available in all countries. Please refer to your Sales Representative.

GE190-004 BIE (Blinded Imaging Evaluation) study – US. A Multicenter Study to Test the Non-Inferiority of Digital Breast Tomosynthesis Compared to FFDM in Detecting Breast Cancer.

© 2014 General Electric Company – All Rights reserved. *GE, GE monogram, SenoClaire and ASIR are trademarks of General Electric Company. MDS DG 38 16 1 D07100968.
McKesson (Tel Aviv, Israel), the well-known healthcare information technology company.

From a cohort of 50 consecutive patients who were scheduled for Transcatheter Aortic-Valve Implantation (TAVI) procedures between September 2011 and February 2012 at the Rabin Medical Centre, Israel we selected 30 patients with both echocardiographic and angiographic examinations. We performed five measurements for each case in both the new iPad application and the McKesson workstation. From the contrast angiography images we obtained 3 measurements: aortic sinus diameter, ST-junction diameter and aortic root angulation [Figure 1]. From the echocardiography modality we obtained 2 measurements: aortic sinus diameter and ST-junction diameter [Figure 2].

Comparison between all five measurements on both display devices (McKesson workstation reports and the iPad measurements) revealed no statistical significant differences in terms of accuracy and precision. The linear regression analysis of the data in all comparisons showed a high correlation coefficient (r>0.9). A Bland-Altman analysis demonstrated good agreement in the angiography images (with mean differences of 0.06±1.55mm, 0.16±1.52mm and -2.06±4.92deg for the sinus diameter, STJ diameter and aortic angulation, respectively) and in the echocardiography images (with mean differences of 0.45±3.25mm and 0.58±2.5mm for the sinus diameter and STJ diameter, respectively).

To estimate reproducibility of the results, assessments of inter- and intra-observer variability were carried out on a set of routinely acquired images.

For the inter-observer test, two radiologists independently analyzed the selected frames, whereas for the intra-observer test, one of the radiologists analyzed the same sets of image 2 weeks after the first analysis and without access to or use of information obtained at the first analysis session. Assessment of the intra- and inter-observer agreement was performed by calculating the Intra-class correlation coefficient (ICC). For all five parameters, the correlation was found to be high and the distribution of differences between both sets of measurements for inter- and intra-observer measurements is around zero implying that the two methods lead to equivalent results. The absolute mean difference was between 0.107mm to 0.377mm for the length measurements, and 0.273 degrees for the angle measurement, thus demonstrating high intra-observer agreement on repeated measurements. The same conclusions can be drawn from the inter-observer repeated measurements, namely 0.047mm to 0.325 mm for the length measurements, and 0.423 degrees for the angle measurement. The Intra-class correlation coefficient (ICC) indicating the resemblance between the two data sets could be considered almost perfect (ICC>0.968 for all cases).

Future perspectives

Other studies are predicting future applications of the iPad in various clinical settings and integration of the platform with other clinical applications. Newer versions of the iPad utilizing 3G and 4G networks for rapid image download and the increasing speed of general internet connectivity look set to enable instant image interpretation from virtually anywhere, thus expanding opportunities for out-of-hospital teleradiology usage.

ACKNOWLEDGMENTS

This study was supported in part by McKesson (Tel Aviv, Israel). The authors would like to thank Tomer Levi and Victor Rutman for their essential contributions to the development of the tablet application.

REFERENCES


