TECHNICAL NOTE / Musculoskeletal imaging

Preliminary experience with tele-sonography and tele-mammography in Togo

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Many medical centres are equipped with a sonograph. However, a sonographist is not always present or is not trained in all of the specialised domains of sonography \cite{1}. A sonogram is not always possible due to a lack of physicians. This situation has given rise to the concept of remote-controlled sonography: tele-sonography, a medical procedure used in remote sonographic diagnosis in real time or deferred time. Tele-sonography can now be carried out in real time by the transmission of the expert’s procedure (robotic system) or by the use of a 3D sonograph in real time \cite{2}. These modes of real time tele-sonography rely on expensive technologies requiring budgets and an infrastructure that is not always possible in developing countries where the needs in tele-medicine are increasing. This paper aimed to present a preliminary evaluation of a “low cost” system of sonographic tele-expertise in real time and the deferred sonographic telediagnosis accompanied by a tele-mammography between expert sites (university hospitals) and isolated sites (peripheral hospitals, dispensaries).

Materials and methods

Technology for the transmission of background videos and the transfer of video sonography sequences in real time or deferred time

An IP (Axis 207W – IP address) video camera installed at an isolated centre (patient centre) and at the expert centre is used for the audio and video transmission (visioconference) between the computer at the patient centre and the expert centre by Internet connexion. An Internet video server (Axis 243 – IP address) connected to the 2D sonograph at the

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doi:10.1016/j.diii.2012.03.020
isolated site is used to transfer sonographic video sequences in real or deferred time via the Internet.

Software for the acquisition and storage of volumes of sonography images and virtual 3D navigation for a deferred diagnostic treatment

Our laboratory (UMPS-Tours) developed software (tele-
sonography acquisition, TEA) to store and save the sonographic video flow as well as decompose video sequences into a series of JPEG images. The files of images generated by TEA are then processed in deferred time by a programme of virtual 3D reconstruction and navigation (ECHO-CNES) (Fig. 1) developed by our laboratory (Licence. EP: 2396773) [3].

Transmission and visualisation of mammography images at the expert centre

The aim is to visualise in real time the sonography images acquired by the isolated operator who is guided by the radiologist at the expert centre according to the previously transmitted mammography images in DICOM format. The use of Dropbox software (Dropbox, Inc., San Francisco) optimises the transmission of mammography and sonography data.

Tele-sonography script

The radiologist at the expert centre, in direct video liaison with an (isolated) patient centre, performs the sonography by guiding the sonographist from a distance.

When the speed of the Internet connection is not sufficiently high between the two sites for an examination in real time, we propose a volume capture by tilt movement with a 2D sound by a sonographist. All of the sonography images are recorded (image volume) by the TEA software. This image volume is sent on a ftp site via internet and the expert recovers it for analysis with the ECHO-CNES virtual navigation programme. The expert moves a section plane in the volume until obtaining the angle required for the diagnosis.

When the speed of the Internet connection is sufficient for a real time interaction between the two centres and the patient centre has a doctor sufficiently skilled in sonography, the expert can combine a first intention expertise in real time and a deferred diagnostic treatment for the final diagnosis. In the case of the mammogram, the expert opens his Dropbox file and identifies the suspect areas in the sono-mammography and guides the sonography physician or sonography technician towards these zones. A written report is then drawn up for the patients and signed by the expert radiologist with the sonography doctor from the isolated centre.

Pilot experiment on the platform

The patient centre was the Tsévié regional hospital centre (teaching hospital) located 35 km from Lomé, the capital of Togo. It has a radiology unit with a 2D sonograph (GE Logiq 200) although there is no radiologist on site to carry out the sonographies. The expert centres are either the Lomé Campus university hospital centre or the Trousseau university hospital in Tours, France (about 4500 km from Tsévié). The system was tested on 22 patients at the Tsévié university hospital.

Data analysis

We analysed the mean speed of the connexion, the possibility of transmitting background videos and sonography sequences, the quality of these transmissions and the results of these examinations in terms of diagnoses in the 22 patients examined.

Results

The mean Internet connexion was 2 Mbps. The quality of the transmission of background videos and video sonography sequences from Tsévié to Lomé was satisfactory (16 images/second) with a maximum delay in transmission of 1.5 seconds (almost in real time). A visioconference was possible between the Trousseau university hospital in Tours, the
Lomé Campus university hospital and the Tsévié regional hospital. This allowed the radiologists at the expert centre to carry out tele-operated abdominal (n = 7), pelvic (n = 4), obstetrical (n = 2), prostatic (n = 2) and mammary (n = 2) sonographs. The sonograph physicians at the Tsévié regional hospital benefited from the expertise of the radiologists at the expert centre by means of guidance by voice and a tele-diagnosis using ECHO-CNES if required. The deferred tele-diagnosis was also used in three patients with the sonography technicians at the Tsévié regional hospital who adequately carried out the tilt movements after three training sessions. The quality of the mammography images tele-transmitted to the expert centre were judged to be suitable enough to guide a tele-sono-mammography (Fig. 2a) in two patients.

A total of 15 sonographs were approved by a normal report. Five sonography diagnoses including one peritoneal tuberculosis, one acute non-lithiasic cholecystitis, one left renal abscess, one left ovarian tumour and one emphysematous cystitis were diagnosed. The two cases of tele-mammography interpreted as normal eliminated suspect mammary lesions in these patients. A closed abdominal trauma patient (susicion of contusion or fracture of the spleen and haemoperitonitis) who should have been evacuated to the Lomé university hospital and in whom the abdominal sonography was normal (Fig. 2b), was finally cared for in Tsévié. The diagnosis of emphysematous cystitis in one patient enabled bladder drainage and antibiotic treatment with satisfactory results, while this patient had been hospitalised for three days and the clinical diagnosis erroneously consisted of an abdominal form of severe malaria and care adapted to this diagnosis.

Discussion

This pilot study let us assess the technical functionality and preliminary diagnosis of our tele-radiology platform. Our system can be considered to be a low cost tele-sonography if we refer to the tele-sonography techniques using 3D or 4D volume acquisition [4,5]. If the centre already has a sonograph and a computer, the total cost of the equipment for the communication is 1500 euros; the Axis 243 internet video server and Axis 207 camera costs respectively 850 euros and 350 euros. This system is therefore accessible for the majority. Popov et al. [6] in the United States proposed technology for the transfer of sonography videos in real time with other relatively more complex data processing equipment using satellite connections. The principle of their technique of tele-sonography is solely based on voice guidance (videoconference) of a radiology technician operating in an isolated centre by a radiologist from an expert centre. Our study uses technology accessible in a tropical African country without the need for an expensive telecommunications infrastructure (satellite). Our system of tele-sonography does not allow the expert to directly handle the sound on the patient at the isolated centre as is the case with certain robot systems such as ESTELE [7] or OTETO [8]. The very high cost of these robots is undoubtedly a hinderence to the use of these systems in poor countries such as Togo. The use of Dropbox software, free and available online, to couple the tele-mammography to the tele-sono-mammograph was motivated by the often inseparable role of these imaging techniques in the exploration of breast disease. The mammography images were transmitted to the expert site in DICOM format, thereby allowing the expert to visualise the images with a quality identical to that of the isolated centre. The tests in Togo were satisfying with a mean speed of 2Mbps. This bandwidth is not very high if compared with that of the cardiology tele-consultation proposed by Boman that requires a speed of 20Mbps [9]. The preliminary diagnostic results are satisfactory although they nevertheless require validation on a larger number of patients with more precise diagnostic evaluation criteria.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.
References


