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The medical and medicolegal use of the radiological image storage PACS for an orthopedic hospital

Ioan Cristian Stoica[1,2,], Stefan Mogos[1,2], Alexandru Draghici[1,2], Romica Cergan[1,2]*

Abstract: Foişor Orthopaedic Hospital is a 119-bed single-specialty orthopaedic hospital. We perform more than 40,000 radiological imaging studies per year, in this moment. Imaging in Orthopaedics in Traumatology is the crucial factor in the diagnostic and taking the final decision required for the orthopaedic/surgical therapeutical act. Tracking the evolution of the case involves comparing the various radiological images obtained during the evolutionary case observation. The preservation of radiological images over time becomes a necessity in our days and this is the current practice in specialized services from abroad. Measuring instruments within the digital radiographic imaging in DICOM format are extremely necessary in current orthopaedic practice increasing the accuracy of information for the benefit of both patients and physicians at the same time. The systematization of radiological imaging with wide access to operators' operating instruments and the storage of data during and after the use of therapy, followed by many years of follow-up (for examples: articular endoprostheses or bone tumours) is a medical necessity. The Foişor Orthopaedic Hospital started to implement PACS solution back in 2010. The Hospital Information System was completed with an integrated system: a digital radiography modality, a computed radiography solution, a RIS and PACS server with 6 TB storage capacity. The paper presents how the radiologic information system has been working in the last 7 years.

Key Words: PACS, radiology, measurements, DICOM, digital imaging, malpractice, medicolegal.

INTRODUCTION

A picture archiving and communication system (PACS) [1] is a medical imaging technology which provides economical storage and convenient access to images from multiple modalities [2].

Implementing a PACS system into a hospital has many benefits: quick access to patient images, view patients' imaging history, make the diagnosing process easier[3]. Digital images give the possibility to use processing tools like modifying the window level values, measurements [4], reconstructions and so on, tools that are not available for film images.

Using the DICOM standard (Digital Imaging and Communications in Medicine), PACS system connects with all the imaging modalities within hospital[5] (digital radiography, computed tomography, magnetic resonance imaging, ultrasound and so on).

MATERIALS AND METHODS

Classical radiographic imaging systems use radiographic films that have image quality loss resulting from support quality, processing system, used substances, exposure, no further processing available after exposure, etc.

The increased number of patients from our hospital generated the need for patient evolution follow-up for implant observation, large storage capacity becoming imperative. Accessing the classical radiology film database available imposed the patient file being retrieved from the archive situated in another location.

1) Foişor Orthopaedic Hospital Bucharest
** Corresponding author: E-mail: stoicacristianioan@gmail.com*
2) "Carol Davila" University of Medicine and Pharmacy, Bucharest

Another observation was the loss of image quality of the classical radiology films in the database as time passed from the exposure moment, another element for conversion to digital imaging.

Modern era radiology systems offers digital image processing, reducing the radiation exposure of the patient and offering numerous possibilities for image processing – quality assessment, image calibration, measurement options, implant templating and preoperative planning and reconstructions.

PACS becoming available, after the conversion to digital imaging offered us, in the last 7 years, the possibility to store a large number of radiologic images, thus offering a dynamic image of patient evolution.

A small comparison of data access, from the imaging point of view – evaluating duration of time, costs and quality of the image obtained, between the period before and after conversion to digital imaging was the main purpose of our paper.

Typical PACS Architecture

A typical architecture consists of a RIS server, modalities, PACS server, diagnosis workstations and viewing stations (Fig. 1).

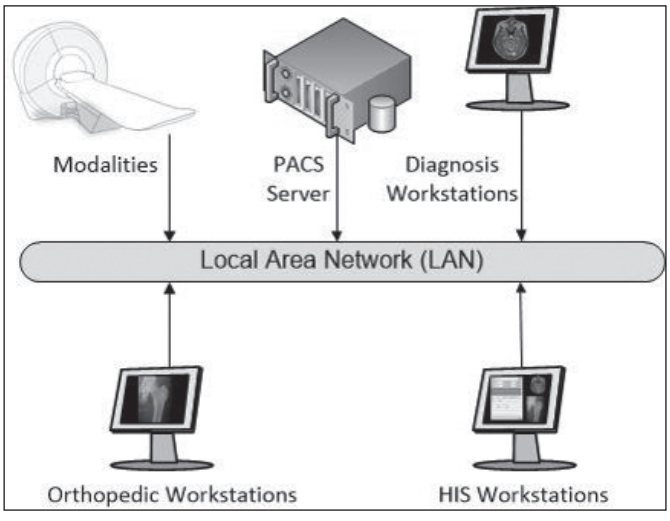

Figure 1. PACS Architecture Scheme.

The RIS server (Radiology Information System) interconnects PACS system with HIS (Hospital Information System) and provides a radiology workflow management.

The main RIS functionalities are: patient scheduling, resource management, examination performance tracking, examination interpretation, and results distribution. The modality queries RIS server for the worklist, download patient demographic information, generate the images and send them to PACS server. PACS server stores and manages the images, and provides access both for radiology department and clinical wards, emergency departments or surgery rooms[6]. The diagnosis workstation is a special type of computer display system that uses high resolution monitor(s) for display and manipulation of medical images from any DICOM modality.

The orthopaedic workstation is a computer with high resolution monitor, where the orthopaedic doctor can use specific measurements, and create preoperative orthopaedic plans with digital templating [7].

HIS workstation is used into any other hospital departments and provides access to electronic health records, including the images.

Foişor Orthopaedic Hospital Implementation

Foişor Orthopaedic Hospital is a 119-bed mono-specialty orthopaedic hospital. We perform more than 40,000 imaging studies per year, in this moment. The Foişor Orthopaedic Hospital started to implement PACS solution back in 2010. The Hospital Information System was completed with an integrated system: a digital radiography modality, a computed radiography solution, a RIS and PACS server with 6 TB storage capacity, five workstations into surgery rooms, one workstation into the clinic department, one workstation into the lecture theater, and three orthopedic workstations for planning and special measurements. The implemented solution was designed using the IHE specifications to assure the smooth communication between all involved modules.

Last year, the information system was upgraded with a CT, a MRI, a new server with 100 TB storage capacity, fifteen orthopedic workstations, nine diagnosis workstations, and eight workstations into surgery rooms. This represents the biggest implementation in Romania till now (most of the big county hospitals has a 20 TB storage capacity PACS servers).

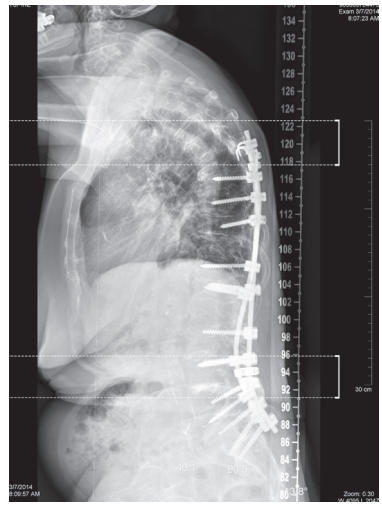

Figure 2. Preoperative standing lateral view X-Ray.

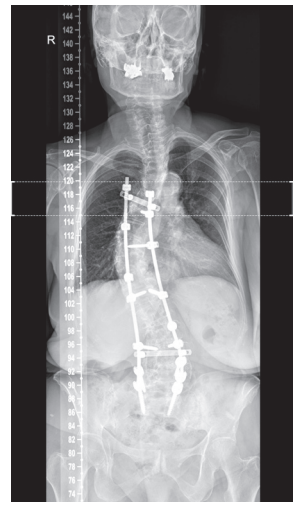

Figure 3. Preop. standing anteroposterior view X-Ray.

From the orthopaedic workstations, the doctors use the specific tools like Cobb angle measurements (Figs 5 and 6)[8], parallel lines, perpendicular lines, and distances (including the image calibration), creates

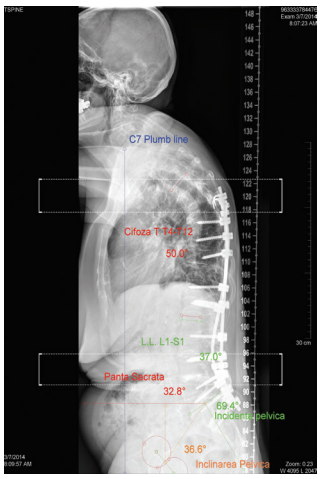

Figure 4. Preoperative lateral standing view X-Ray with sagittal balance.

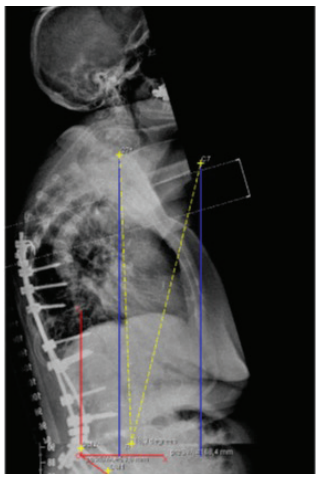

Figure 5. Preoperative lateral standing view X-Ray with spinal osteotomy planning.

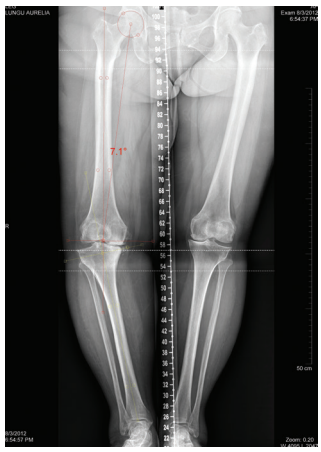

Figure 7. Standing X-ray for lower limb axis preoperative for the right knee arthroplasty.

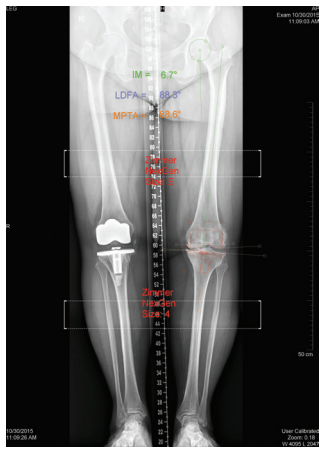

Figure 8. Standing X-ray preoperative planning for left knee arthroplasty and control for right knee - 3 years 6 months postoperative.

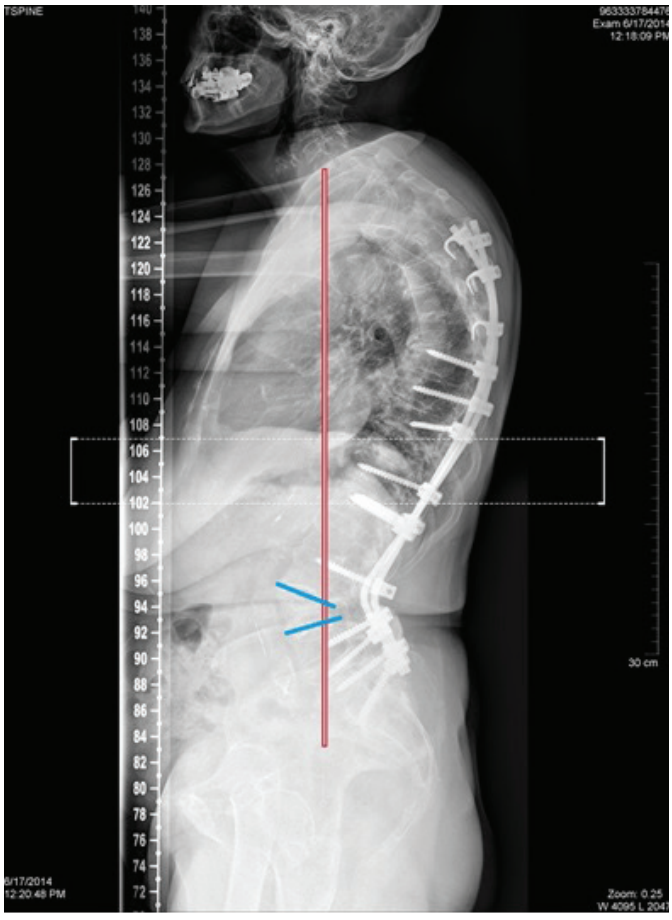

Figure 6. Postoperative lateral standing view X-Ray.

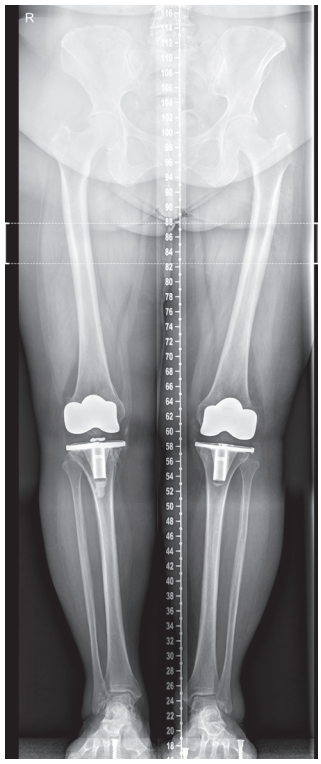

Figure 9. Periodic control - right knee 3 years 9 months; left knee 3 months postoperative.

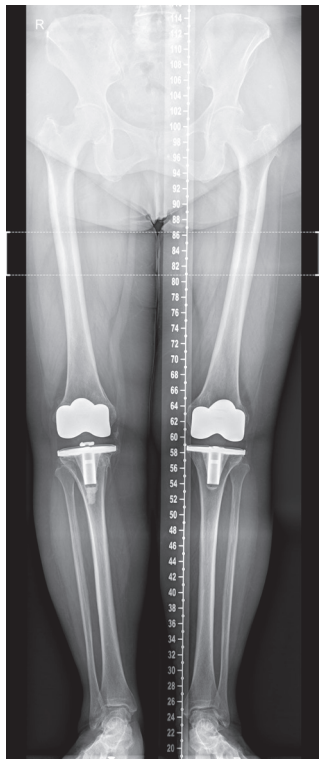

Figure 10. Periodic control - right knee 4 years 6 months; left knee 1 year postoperative.

and saves preoperative orthopaedic plans with digital templating [9]. Every morning we discuss the proposed planning in the lecture theatre to take the best decision for the patient. We have rapid access to the images anytime and anywhere.

A PACS system enables recording the entire bulk volume of information resulting from the imaging investigation instead of a succession of images selected by the specialist and distributed on paper film or optic media. This enables dynamic comparison through serial imaging studies of evolving chronic pathology (Figs 7, 8, 9, 10) to decide upon the optimum moment of initiating surgical treatment, introducing articular endoprosthesis or even evolutional postoperative controls.

PACS is a closed system that can ensure the security and confidentiality of patients' data instead of older filling systems that were prone to hacking. Moreover, it will provide the basis for integrating orthopaedic departments with national and international Endoprosthesis Registries and Bone Banks.

Furthermore, it will lower the costs and expedite the treatment decision through portability with paperless

capabilities. Cost-efficiency will be assured by minimizing the costs with radiology film and printing toner.

The aspects will contribute to the creation of a virtual platform of teaching and scientific analysis of data for students, residents in training [10] – a usual situation in other countries, master students and PhD.

Considering an approximate volume of annual data of 4TB in our storage system of 100TB we could keep information over 20 years. These data are essential in long statistical studies for evidence-based future diagnosis and treatment guidelines development and population studies.

All the data recorded from a patient has virtual endless medical and legal outcomes thus keeping them in the PACS system will diminish the risk of malpractice from the medicolegal point of view.

RESULTS

Using digital imaging has the benefits of an almost instant access to all the radiologic data for a certain patient, no costs in obtaining the data and the constant quality of the data retrieved. The system is able to retrieve not only the radiological examinations but also the saved preoperative measurements. We observed a decrease of the number of radiographs for each patient after the conversion, a decrease of the individual radiation exposure and a slight reduction of misdiagnosis at the first presentation of the patient in the emergency room.

The 40000 radiologic examinations taken yearly since the system has been installed gave us the possibility to observe the patients' evolution from the preoperative status, the postoperative control x-ray and the periodic examinations, being able to measure the safety elements of the implants – determining the moment for surgery in an early phase – this way preventing complications and major surgeries.

Educating patients in the spirit for periodic radiologic check-ups associated with all the other patient-outcome measures led to a longer survivability of the implants and a quality increase in the surgical procedure.

CONCLUSIONS

The creation of a national centralized digital storage center (national data center) for the radiological imaging with multiple users storing all the images made by the patient during life, could create the premise of its follow-up throughout life without losing important evolutionary information.

For the moment, the local solutions applied in our unit have greatly improved the quality of patient care.

Measuring instruments within the digital radiographic imaging in DICOM format are extremely necessary in current orthopaedic practice increasing the accuracy of information for the benefit of both patients and physicians at the same time.

The ability to access the radiological imaging history of the patient can be used both in analysing and solving cases and later during case analysis from the medicolegal point of view.

Conflict of interest. The authors declare that they have no conflict of interest concerning this article.

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