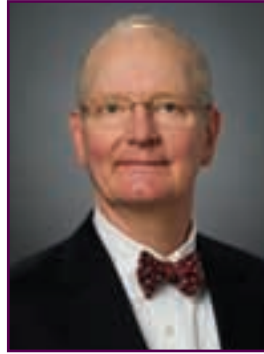


CLINICAL PERSPECTIVES ON

IntelliSpace Portal





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INTRODUCTION

IntelliSpace: at the heart of Imaging 2.0

IntelliSpace Portal is an imaging software platform that is designed to help improve workflow, communication, and collaboration, and ultimately help improve patient care. This report summarizes the main features of the system, with reference to supporting clinical data and real-life case studies from centers that have been pioneering the use of the portal.

IntelliSpace encapsulates the new concept in imaging technology introduced by Philips known as Imaging 2.0, which is underlying current product development. The Imaging 2.0 concept acknowledges that radiologists should be at the center of clinical decision making, armed with the necessary tools for sharing information easily and collaborating efficiently with the referring doctor and other physicians. By enabling greater interaction between physicians and radiologists, and effective integration of imaging hardware and software, the quality of care for patients can be improved, and also be made as cost-effective as possible.¹

Collaborate and diagnose virtually anywhere

IntelliSpace Portal can be thought of as a 'virtual cockpit', with the radiologist as the 'pilot', directing information exchange and collaboration. Its key features include:

- The ability to access data and images virtually anywhere
- A wide range of dedicated, advanced clinical applications for MRI, CT, and nuclear medicine
- Tools to improve collaborative workflow
- Centralized data management, for the purpose of reducing download times.

IntelliSpace is a multimodality, multivendor, advanced visualization server. Once installed at a center, data and images saved to this central server can be accessed and manipulated from any authorized workstation, PC, laptop computer, tablet, or even smartphone, via a broadband Internet connection and the center's virtual private network. The portal allows radiologists, physicians, and any other authorized invited parties – virtually wherever they are – to discuss patient cases in real time. This can be expected to lead to fast and more accurate diagnoses. The central server can rapidly process MRI, CT, and nuclear medicine data, and has a large storage capacity. IntelliSpace also interfaces fully with the center's existing picture archiving and communication system (PACS). Data and images sent to the PACS can be accessed through IntelliSpace Portal, manipulated via the relevant clinical application, and sent back to the PACS as a new dataset. A total of 32 clinical applications are available through IntelliSpace Portal, and include advanced vessel analysis, CT lung nodule assessment, comprehensive cardiac analysis, MR neuro perfusion, and virtual colonoscopy (see box).^{2,3}

Improved patient care

The potential benefits of IntelliSpace for patient care are best illustrated through some real-life examples. The case studies presented in this article focus on maxillofacial surgery, brain perfusion, cartilage assessment, collaboration/education, comprehensive cardiac analysis, and tumor tracking, and illustrate how IntelliSpace can contribute to efficient care. For each of these case studies, Dr George M. Ebert, Associate Professor of Radiology, University of Vermont, USA, has provided a brief descriptive commentary. Dr Ebert points out that 'with the IntelliSpace Portal we are now able to achieve a more efficient workflow on a day-to-day basis. From the automated pre-processing to the streamlined post-processing tools, we save time across many different areas. The portal is also effective in opening the door to effective real-time communication between the radiologist and the referring physician.'

Time savings

IntelliSpace clinical applications can lead to significant time savings, as steps previously performed manually are now semiautomated or automated. To illustrate this, a comparison was made between the time spent performing CT angiography image analysis using the portal's advanced vessel analysis application, and the time spent on the same procedure using a conventional workstation. The total time spent on abdominal aorta analysis (including endoluminal graft measurements) with IntelliSpace Portal was 11–15 minutes, the breakdown of which was as follows:

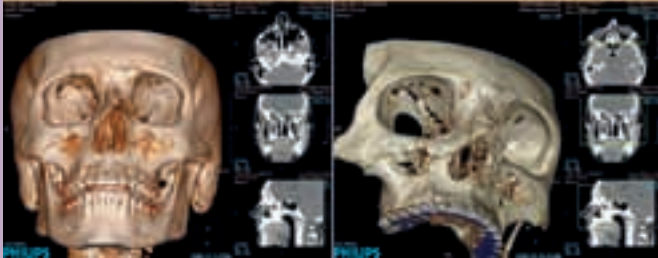
- Remove bone images (Figure 1) – an automated process: 3–4 minutes
- Clean up image and save 3D batch: 1–2 minutes
- Perform vessel extraction and batch aorta/iliac maximum-intensity projection images (MIPs): 2 minutes
- Perform stent measurements and save data: 2–3 minutes
- Open review screen and save vessel MIPs: 3–4 minutes.

This total workup time of 11–15 minutes using IntelliSpace Portal compared favorably with the corresponding time needed using a traditional workstation, which was at least

CASE STUDY 1

Maxillofacial surgery

'The 3D reformation and segmentation tools allow us to communicate detailed findings in one image. The two teenagers in these pictures have their whole lives ahead of them, so it is especially crucial that surgeons understand the full extent of the injury in order to plan for the subsequent surgery. With these one-click 3D reformations, surgeons are able to look at the fracture with both conventional views and virtual views that would be difficult to see in the operating room.' (Dr G.M. Ebert)



Case 1A: 'This 16-year-old male received facial trauma in an all-terrain vehicle collision. He was not wearing any protective gear, and sustained multiple facial and orbital fractures, detailed clearly in these two images.'

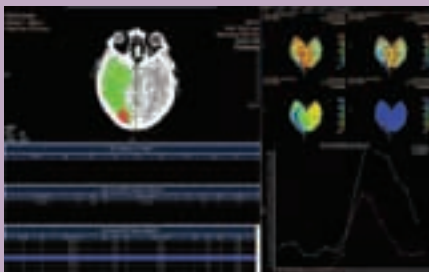


Case 1B: 'This 17-year-old female complained of jaw pain after playing a soccer game in which she was hit in the face by a player's knee. These images highlight the mandible fracture involving the mentum, which may go through the root of tooth number 24. There is a left mandibular comminuted ramus fracture.'

CASE STUDY 2

Brain perfusion

'With the IntelliSpace Portal, images can be accessed and manipulated remotely. We are all familiar with teleradiology, but IntelliSpace brings it to the next level: unlike the post-processed static images that are seen in PACS, we are able to create, modify, and interact with this information as easily as if we were at the CT scanner console or at a traditional hospital-based workstation. It virtually reduces any barrier of distance.' (Dr G.M. Ebert)



Case 2: 'These images are of a 72-year-old female with tandem carotid lesions, who presented with left-sided weakness. We evaluated her for perfusion deficit. The patient had a large area of brain at risk, and was a good candidate for intra-arterial therapy. The remote access offered by the IntelliSpace Portal allowed the interventional team to make a real-time evaluation of the scan findings, which may have helped to improve care.'

'IntelliSpace has revolutionized radiologists', clinicians', and technologists' ability to view and process images . . . The Brain Perfusion application is used for stroke patients and provides fast results. The bone and skull removal capabilities are exceptional, and it displays vessels in a 3D volume that is superb.'

Heidi Streeter, BSRT (R) (M) (CT), 3D/CT Imaging Technologist, Fletcher Allen Health Care in alliance with the University of Vermont, Burlington, VT, USA (involved in beta-testing IntelliSpace Portal)

60 minutes.⁴ Similarly, the total time spent on analysis of a carotid and cerebral angiogram using IntelliSpace Portal was found to be 8–12 minutes, including 3–4 minutes for skull-image removal (Figure 2), plus a further 1–2 minutes if stenosis measurements were required. Again, this was a much shorter time than the 60+ minutes needed using a traditional workstation.⁵

Automated pre-processing by IntelliSpace accounts for significant time savings. As soon as data are sent to the portal, image preparation work is performed automatically. By the time a radiologist or physician opens up the case, this image preparation work will typically already have been completed, and evaluation can begin.



Figure 1. Automated bone-image removal using IntelliSpace Portal: the screens show images before (left) and after (right).

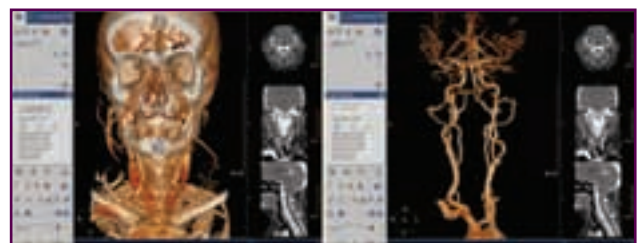


Figure 2. Automated skull-image removal using IntelliSpace Portal: the screens show images before (left) and after (right).

'Franciscan St. Francis Health has used [the Multimodality Tumor Tracking (MMTT) application] as a communication medium between research coordinator, radiologist and CT department when evaluating cancer research patients in CT. Our oncology research nurses especially like that MMTT is compliant with RECIST (Response Evaluation Criteria In Solid Tumors). We have also received positive feedback from our radiologists [who want] a solution that increases their efficiency when locating and measuring target lesions on multiple studies. Our 3D lab's involvement has the potential to help them in their report turnaround for these cases.'

*J. Louis Rankin, 3D Lab Technical Coordinator, Franciscan St. Francis Health, Indianapolis, IN, USA
(involved in beta-testing IntelliSpace Portal)*

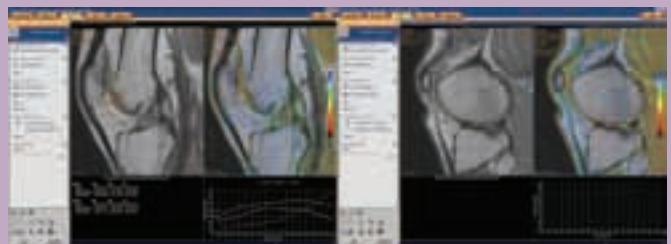
The accuracy of the software underlying the fully or semiautomated processes in IntelliSpace has been evaluated thoroughly. One study presented at the 2011 meeting of the Radiological Society of North America (RSNA) investigated the semiautomated quantification of myocardial enhancement defects on cardiac CT angiography. The researchers studied 26 patients who underwent a 64-slice cardiac CT scan, and reported there was 'an excellent correlation' between the volume of myocardial hypoenhancement calculated with the software and the volume calculated from manual contouring (Spearman's rho coefficient 0.9; $p < 0.0001$).⁶

In a separate study, researchers assessed the automated algorithm for identifying and quantifying myocardial perfusion defects or infarction from cardiac CT images, and concluded that the method 'showed good agreement' with expert analysis of the images.⁷

CASE STUDY 3

Cartilage assessment

'Our musculoskeletal division has been excited to bring T2 mapping research into our everyday practice. The cartilage assessment tool will aid the detection of cartilage lesions, and we can provide this as an added service to patients who present with any of a wide range of injuries and/or altered biomechanics.' (Dr G.M. Ebert)



Case 3: Cartilage assessment anterior (left) and cartilage lesion area (right).

Advanced clinical applications available for IntelliSpace Portal

- Multimodality tumor tracking
- Advanced vessel analysis
- Customized reports
- Comprehensive cardiac analysis
- CT coronary plaque analysis
- CT calcium scoring
- CT virtual colonoscopy with perspective-filet view
- CT lung nodule assessment
- Lung density
- CT advanced brain perfusion
- Functional CT
- CT organ perfusion
- CT viewer
- CT myocardial perfusion
- Multiphase CT cardiac
- Cardiac viewer
- NM viewer
- CT NM cardiac fusion
- Volume rendering
- MR neuro perfusion
- MR diffusion
- MRTI perfusion
- MR MobiView
- MR subtraction
- MR echo accumulation
- CRT Endo
- VIP, surface MIP, MIP, minMIP, and average displays
- Full slab review capabilities
- Multiplanar reformations in curved, paddlewheel, and MasterCut
- Full 2D capabilities, including compare, pan, zoom, scroll, region of interest, and annotation
- High-priority log-in for emergencies, regardless of network traffic
- Lossy or lossless compression

'The Advanced Vessel Analysis and CT viewer options have been real time-savers for us, and I am always proud of our results. The Brain Perfusion application has been simplified to a few mouse clicks. I like the fact that you can save quickly these results to PACS either by location or map type. We find the Virtual Colonoscopy package also very user-friendly and intuitive.

The Lung Nodule assessment shows improved editing and verifying functions as well.'

*Sandra Hudson, RT (R) (CT) (MR), Fletcher Allen Health Care in alliance with the University of Vermont, Burlington, VT, USA
(involved in beta-testing IntelliSpace Portal)*

CASE STUDY 4

Collaboration and education

'We found that the portal really opens the door to real and effective peer-to-peer communication as it pertains to image analysis in studies such as cardiac CT angiography, brain perfusion, cartilage assessment and multimodality tumor tracking. In particular it is very useful when discussing results with a non-radiologist, who has a basic knowledge of imaging but doesn't use it on a day-to-day basis. Both the consultant and the referring physician(s) can view and manipulate the images at the same time, using virtually any computer or mobile device, wherever they are. We can have a consultation and discussion at a depth that would be much more difficult to achieve through the usual communication routes of written reports or telephone conversations. You can sit virtually 'side by side' wherever you are in the world.'

(Dr G.M. Ebert)

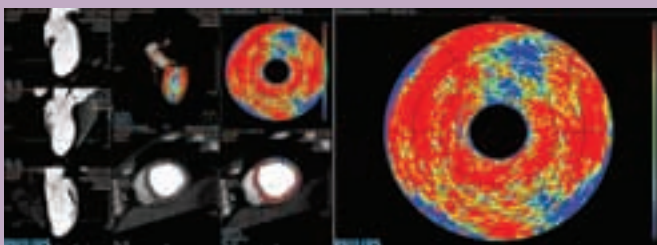


Collaboration view.

CASE STUDY 5

Comprehensive cardiac analysis

'The various tools within the IntelliSpace Portal allow for a comprehensive cardiac analysis. When what looks like a hemodynamically significant lesion is in question, the perfusion mapping feature allows for that 'final check' to improve the confidence in the diagnosis (without any additional radiation exposure). Here we see a left anterior descending artery (LAD) lesion: the perfusion map shows decreased perfusion to the anterior wall.' (Dr G.M. Ebert)

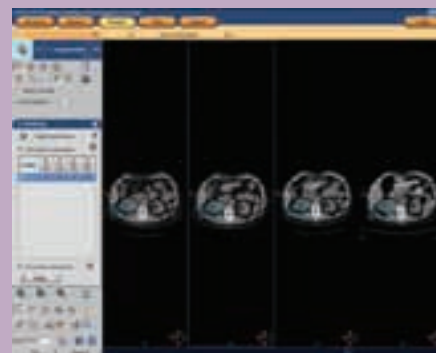


Case 5: Cardiac map display (left) and large cardiac map (right).

CASE STUDY 6

Tumor tracking

'The multimodality tumor tracking tool allows us to easily evaluate the response to treatment over time. As well as helping us to improve routine care for patients with cancer; it provides useful information for basic research and drug trials.' (Dr G.M. Ebert)



Case 6: Lesion development over a period of 7 months.

'The IntelliSpace Portal has been a very useful tool in our daily clinical practice. We provide a radiology service organized by organ system, and collaborate closely with internal medicine physicians, surgeons, radiotherapists, oncologists, etc. Multidisciplinary assessment and evaluation is greatly facilitated by the portal, which allows access from any computer.

Management is intuitive and simple.'

(Dr Enrique de Miguel Campos, Diagnostic Radiology Department, Hospital General Universitario Gregorio Marañón, Madrid, Spain (involved in beta-testing IntelliSpace Portal))

Further information

If you would like more information on IntelliSpace Portal, go to:
<http://www.healthcare.philips.com/main/products/Solutions/IntelliSpaceportal/index.wpd>



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