WHITE PAPER

Enterprise Imaging

Enhanced Hanging Protocols

AGFA HealthCare

1. What are "Hanging Protocols"?

Originally, the term "Hanging Protocol" referred to the arrangement of physical films in a film box or the hanging of films on a film alternator. These days, the term is used for the display of softcopy images on a PACS workstation. But in both cases, the purpose of a Hanging Protocol is to present specific types of studies and images in a consistent manner. This can drastically reduce the amount of manual image arrangement and display adjustment required from the radiologist or clinician, thus improving overall operational efficiency.

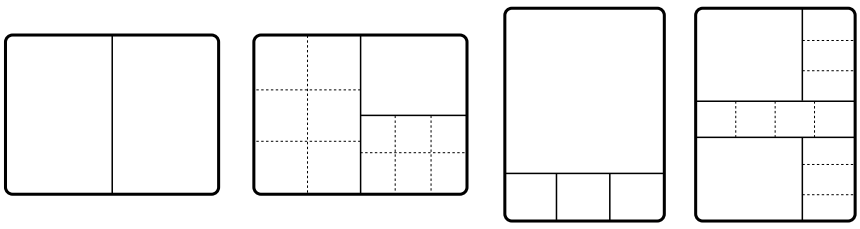
In the past, the radiologist's assistant manually arranged the films depending on modality, displayed body part, procedure type and the radiologist's own personal preferences. A well-designed digital Hanging Protocol system uses the same criteria. Furthermore, the user expects both smart behavior from the system with regard to variations in the acquired images, and easy configuration and adaptability in the face of changing needs and procedures.

2. What can be defined by the Hanging Protocol ?

The Hanging Protocol displays the available data in a way that allows optimal and efficient reading for the user. To do so, it specifies a variety of parameters:

2.1 Layout:

The Hanging Protocol controls the division of the screens into viewports, the places where the images and series are displayed, and the arrangement of these viewports. The number of viewports and their arrangement is virtually unrestricted, with two exceptions: namely, viewports must not overlap, and there must not be any gaps (i.e. undefined or blank regions) within the layout. The layout definition also specifies whether a series consisting of multiple images should be viewed in a stack or tiled manner. Here are some examples of possible layouts for landscape and portrait monitors:



Examples for different screen layouts

2.2 Series placement:

The Hanging Protocol also controls where series are displayed within the layout. To do so, all images from a study are first split into a new, well-defined set of series. This

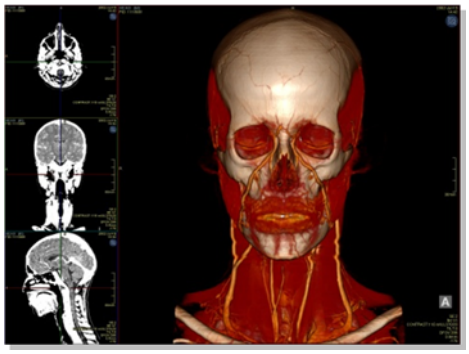
compensates for any incorrect splitting that might have occurred at the modality, and ensures that the same kind of data will always be split and identified in the same way, even if it comes from different modalities. For example, localizer and scout images can always be identified, regardless of whether the modality sent them as a distinct series or as part of another series.

This allows localizer images to be consistently displayed in a specific position within the screen layout. Various DICOM tags can also be used to determine the positioning of series. For instance, the user might want to use the DICOM tag "View Position" to distinguish the visual field of an X-ray related to the patient's position to always see the posteroanterior view on the left screen, and lateral images on the right screen. This allows for correct splitting even in more complex scenarios, like multiphasic examinations or 4D studies.

The system permits the display of the same series or image multiple times simultaneously – e.g. a series of CT images with bone and lung window/level preset, side by side. Series selection is also possible across multiple studies, to be able to create comparison Hanging Protocols that show active and prior studies simultaneously.

2.3 Rendering algorithm:

Although the term "Hanging Protocol" suggests that only the "hanging", i.e. the layout, is affected, a modern PACS workstation, like the Agfa HealthCare Enterprise Imaging platform, provides many more ways to enhance reading. Far from displaying only the native images, the Hanging Protocol can also use specific rendering algorithms for display, e.g. 3D rendering, MPR (multiplanar reformation) views, or MIP (maximum intensity projection) views. Extended 2D views, such as animated cine view or integrated 3rd party rendering, can also be triggered automatically by the Hanging Protocol.
Here is an example for a typical 3D CT Hanging Protocol showing a 3D rendering next to an MPR view of a dataset:



Example for a typical single-screen, 3D CT Hanging Protocol

2.4 Parameter specification:

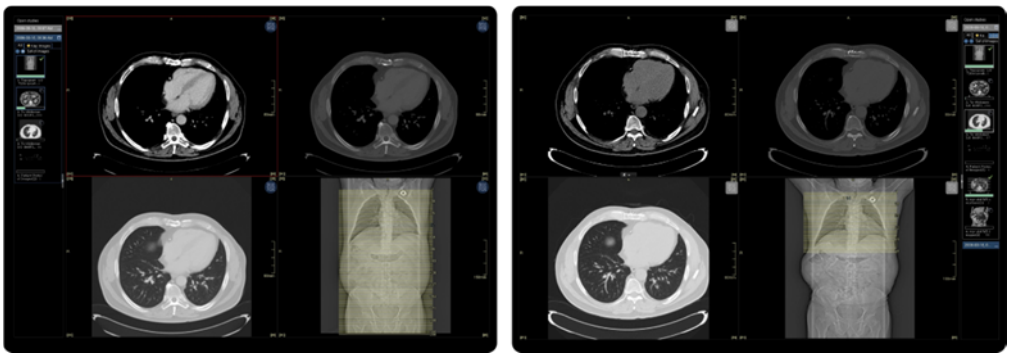
Various parameters influence the optimal display of images or enhanced renderings. All of these parameters can be specified through the Hanging Protocol. Prominent examples include window/level presets for 2D image display, the zoom factor (e.g. pixel 1:1 zoom) and, for 3D display, the transfer function that should be applied or the initial orientation of the volume. More enhanced parameters, such as automatic mirroring for mammography display, can also be specified through the Hanging Protocol. The end-user will not see all of these parameter options, in order to keep Hanging Protocol generation simple, but they can be specified and changed by Agfa HealthCare professional services.

2.5 Linking and synchronization:

Often, users want images and series synchronized or linked according to certain criteria. This means automatically applying the adjustment of a specific value on one series to another series as well. Within the Hanging Protocol, it is possible to specify exactly which series are to be linked according to which parameters. For each parameter, several linking groups can exist, synchronizing changes within the group, but not across groups.

For example, the user could create a CT comparison Hanging Protocol that shows a CT series twice on the first monitor, once with a bone and once with a lung window/level preset; a CT comparison study can also be displayed twice on the second monitor. All four series can be linked for navigation. When navigating through the stack of the current CT series, all four series will automatically follow. This can be done in an anatomically correct way, allowing the studies to stay in sync even if slice thickness and distance vary between the current and the comparison studies.

For window/level, the user could create two groups, one consisting of the lung preset for the current and the comparison studies, and the other consisting of the bone preset of the current and the comparison studies. If the window/level setting in the viewport displaying the lung preset of the current study were adjusted, the viewport showing the lung preset of the comparison study would adapt its values as well.



Complex linking example, showing a current study on the left screen and a comparison study on the right screen. Each study shows one series with three different window/level settings, with the window/level settings linked between current and comparison studies. Zoom and pan are linked for the viewports within each study, and navigation is linked across the studies.

2.6 User interface:

Some studies require extended or specific versions of the user interface (UI) for in-depth diagnosis. In such cases, the Hanging Protocol engine can also control the visible UI elements. Typical examples include: enhanced cardiac ultrasound studies, for which users want quick access to various cardiology measurement tools, or XA studies, for which users might want direct access to cine tools.

2.7 Workflows:

Real-life reading workflows can be complex; therefore, the Hanging Protocol is not restricted to a single, static layout, but can in fact represent a full sequence of various Hanging Protocols. Triggered by the examination's procedure code, these workflows - or even specific Hanging Protocols within them - can be used as entry points for the reading workflow. Simple tools allow the user to navigate within the different Hanging Protocols to streamline the reading workflow.

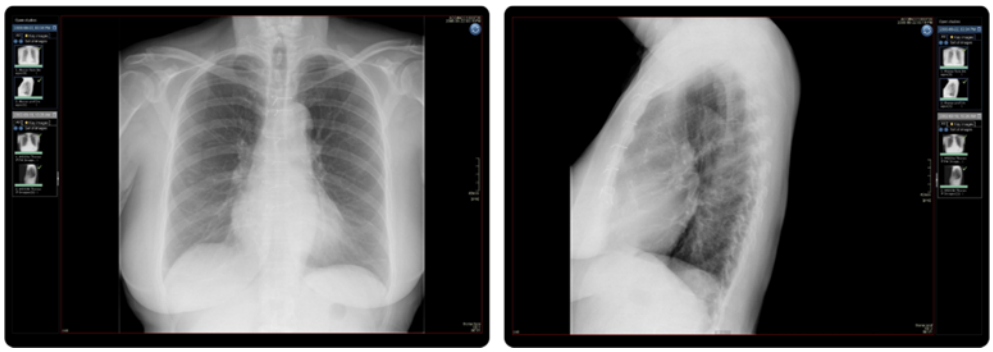
2.8 User-specific Hanging Protocols:

Users may have individual preferences regarding how they want their data represented. It allows for easy modification of Hanging Protocols, and users can create and modify their own copies or even create new Hanging Protocols from scratch. As the selection of Hanging Protocols can be triggered by e.g. the procedure code, the optimal Hanging Protocol for each study can be automatically determined and applied. Again, this mapping can vary from user to user, to accommodate personal preferences.

4. Hanging Protocol examples

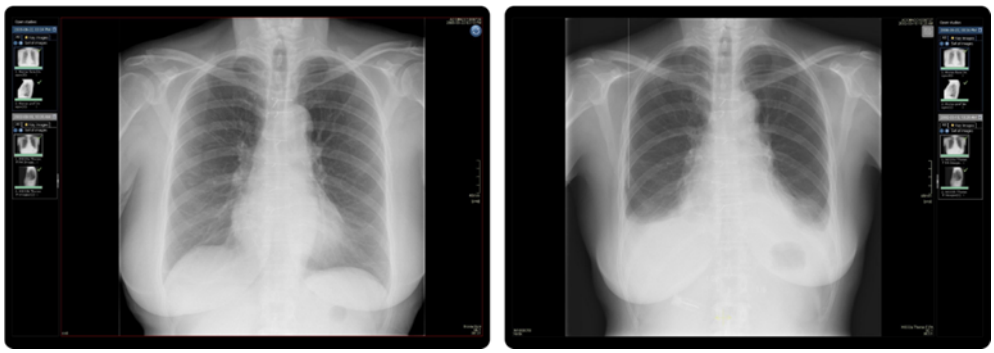
4.1 Chest X-Ray:

Starting with the current study, the system ensures that the left monitor always displays the posteroanterior image and the right monitor always displays the lateral image:



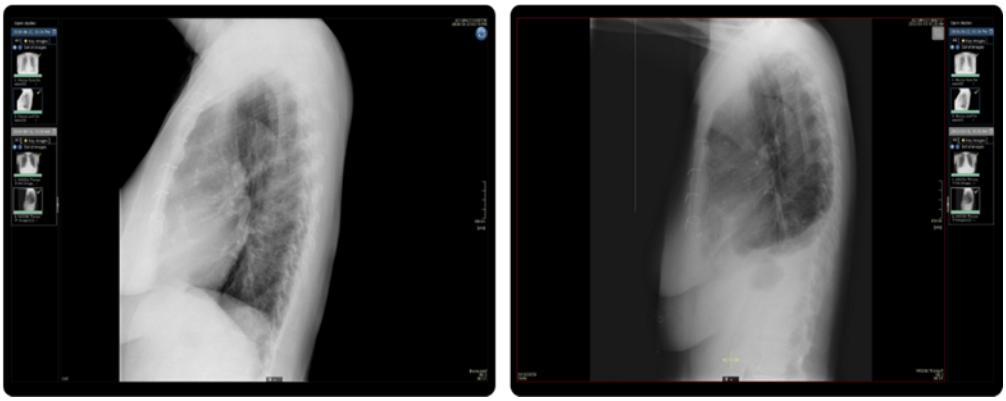
Example for a typical chest X-ray Hanging Protocol

When adding a comparison study, the system automatically switches to a comparison Hanging Protocol. Depending on the user's preferences, this might be a layout showing the posteroanterior images in a one-up, with the current study always displayed on the left screen and the comparison study on the right screen:



Comparison of posteroanterior chest X-ray images

A single mouseclick will switch to the next Hanging Protocol within this chest CR comparison workflow that now shows the current lateral image on the left screen and the lateral image of the comparison study on the right screen:

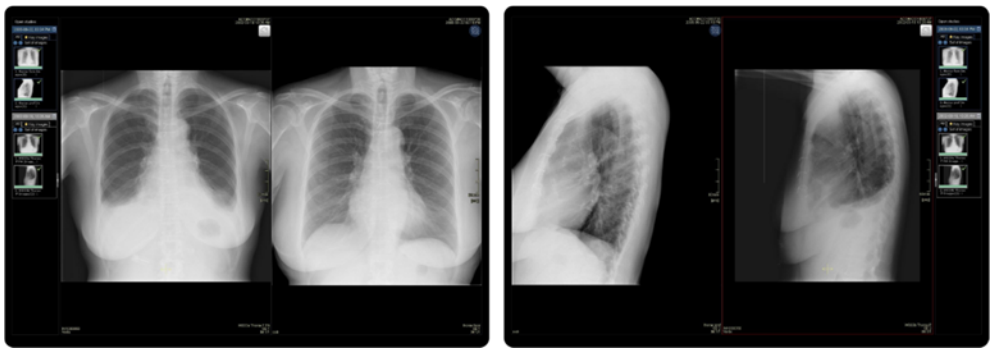


Comparison of lateral chest X-ray images

Either as another step within this workflow, or as an entry point to the comparison workflow, the Hanging Protocol could also show an overview with both posteroanterior and lateral images for the current study on the left screen, and those same images from the prior study on the right screen:

Comparison of current and prior X-ray images

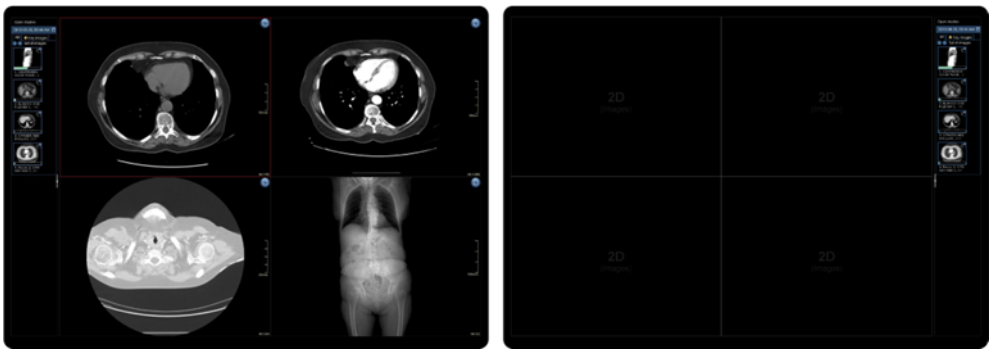
Alternatively, the user might prefer to see both posteroanterior images (current and prior) on the left screen and both lateral images (current and prior) on the right screen. The Hanging Protocol can make sure that the two inner images show the current study and the two outer images show the comparison studies, thus combining two different studies on each screen:



Alternative comparison showing a mix of the studies per screen

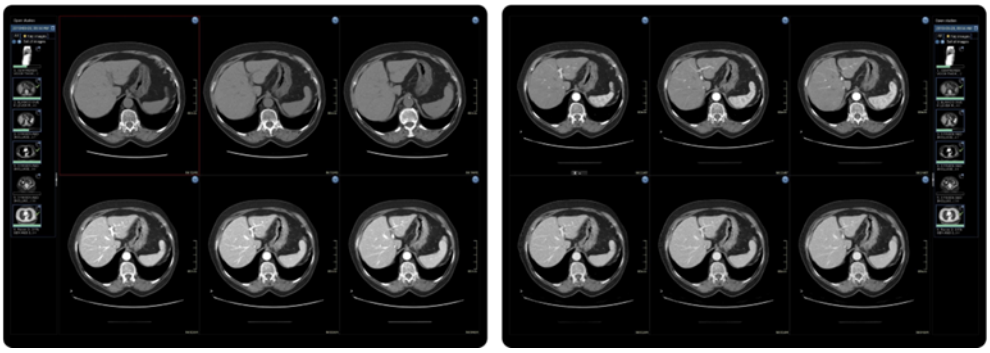
4.2 CT examinations:

A good starting point for a CT examination is an overview Hanging Protocol displaying the first seven series as stacks on both monitors, with each screen divided into 2 X 2 viewports. The lower right viewport on the left screen is dedicated to the localizer image. If the CT study has fewer series, the remaining viewports stay empty, as in the following example:



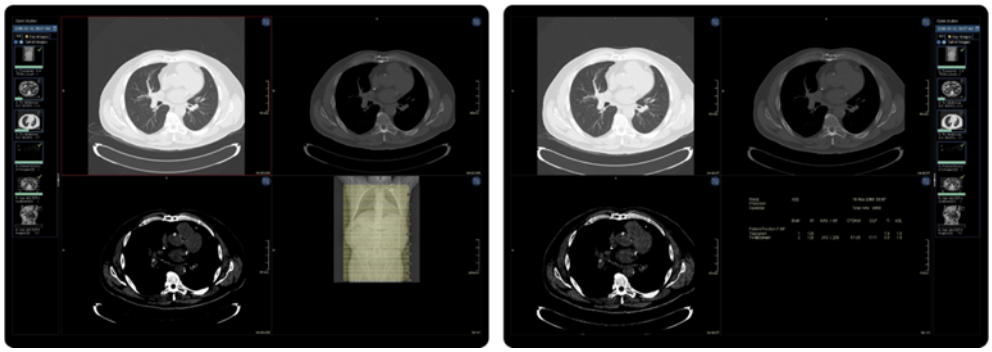
Overview Hanging Protocol showing all series and the localizer

Sometimes a dataset requires a very specific splitting for good display management. The following example shows a multiphasic liver examination, with the different phases split into separate series and shown next to each other, in a display of three images from each series in tiled mode:



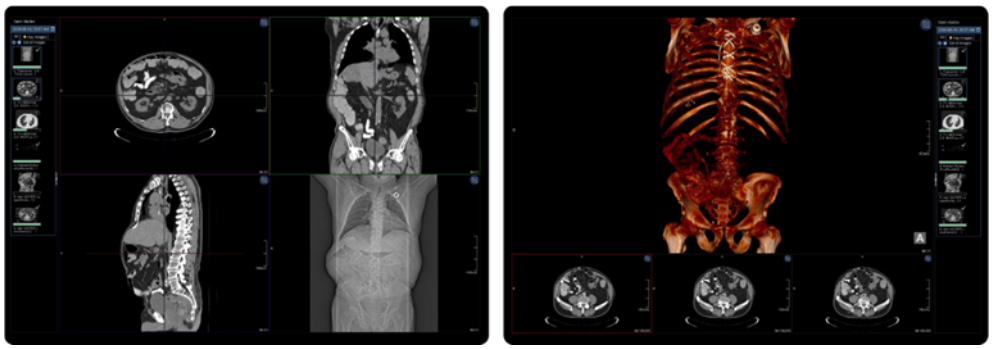
Hanging Protocol showing phases of a multiphasic acquisition split into separate series

The system also allows the display of the same series multiple times on one screen. Here, a Hanging Protocol is shown that displays on each screen one series with three different window/level presets. Complex linking allows the synchronization of the different window/level settings and navigation per series. The fourth viewport on each screen shows the localizer image and the protocol image:



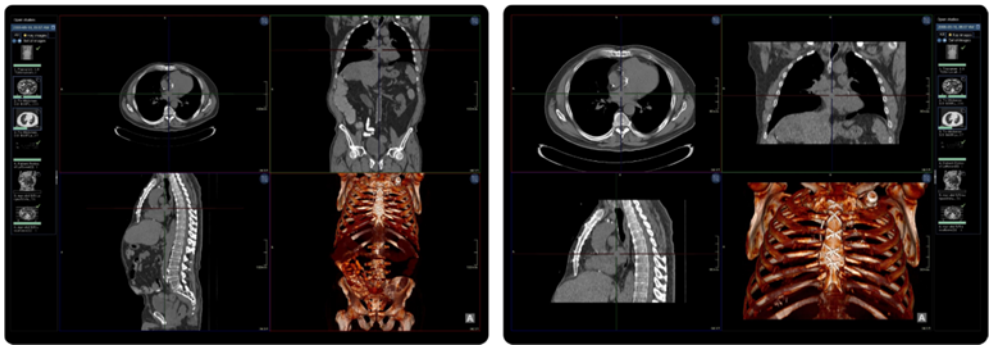
Each monitor displays a series three times with different window/level presets applied

3D renderings can be incorporated in the Hanging Protocol, as well. The next example shows three MPR views combined with the localizer image on the left screen; and a 3D rendering, together with a tiled view of the series used to create it, on the right screen:



A Hanging Protocol combining 2D and 3D renderings

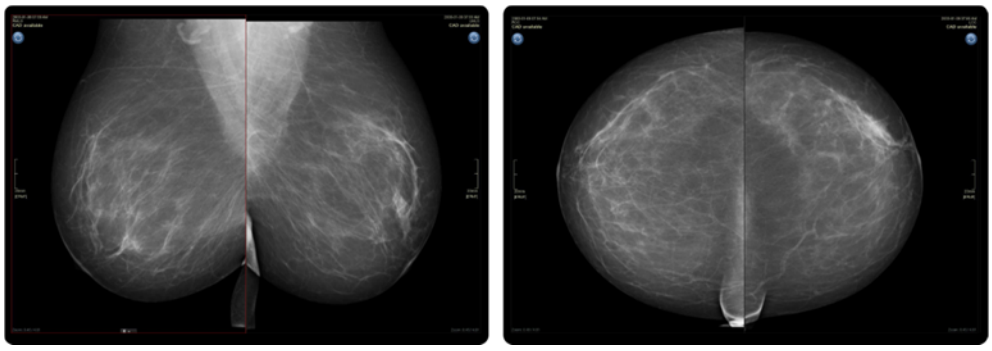
The system does not limit the number of 3D renderings used within a Hanging Protocol - comparison of MPR and 3D views from two different series can easily be done:



Comparison of 3D renderings of two different series

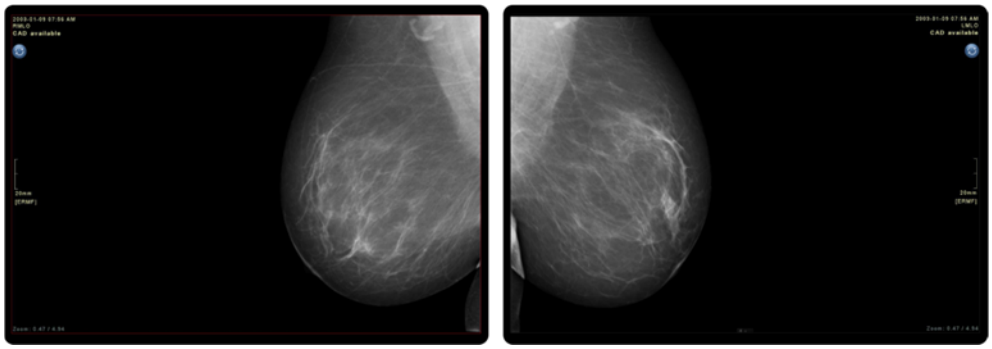
4.3 Standard mammography workflow:

The Hanging Protocol's benefits are especially significant for well-defined workflows such as those for mammography. Here, an example for a very basic workflow is given, starting with an overview Hanging Protocol showing all acquired images. Mammography-specific features such as chest wall alignment and sizing constraints are automatically applied via the Hanging Protocol:



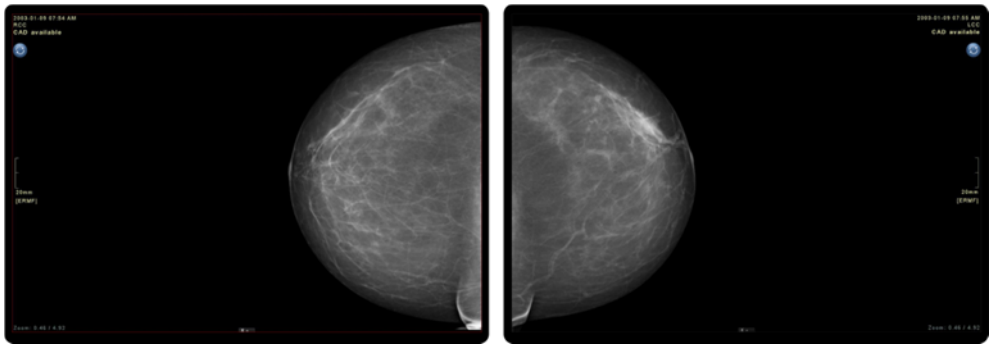
Overview as entry point for a mammography Hanging Protocol workflow

The next Hanging Protocol of this workflow will show the mediolateral oblique views of the right and left breasts...



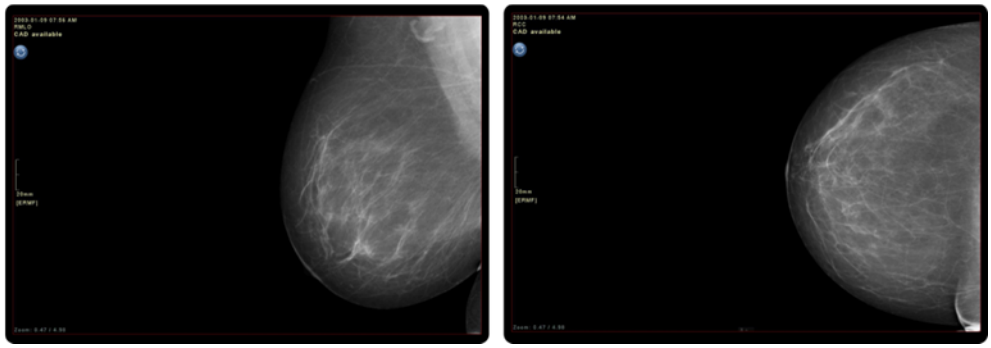
Mediolateral oblique images

...followed by a Hanging Protocol showing the cranial-caudal views:

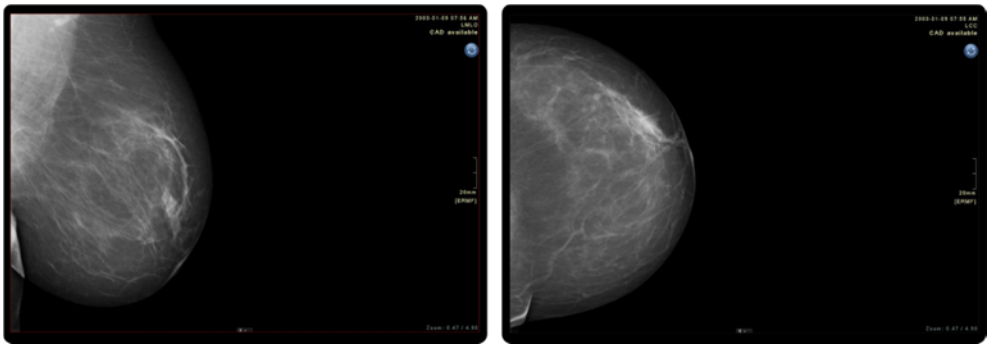


Cranial-caudal images

The next two Hanging Protocols show both the mediolateral oblique and the cranial-caudal views of one breast; first for the right breast, then, within the next Hanging Protocol, the same for the left breast:



Comparison of mediolateral oblique and cranial-caudal views of the right breast



Comparison of mediolateral oblique and cranial-caudal views of the left breast

This is just one example for a very basic mammography workflow. Based on the Hanging Protocol engine, complex workflows including latero medial views, zoomed views, retakes, skipping of empty workflow steps and, last but not least, multi-modality mammography examinations can be supported. The Hanging Protocol can also display an overview of images that did not fit into any of the above mentioned categories.

Agfa HealthCare, a member of the Agfa-Gevaert Group, is a leading global provider of diagnostic imaging and healthcare IT solutions. The company has nearly a century of healthcare experience and has been a pioneer on the healthcare IT market since the early 1990's. Today Agfa HealthCare designs, develops and delivers state-of-the-art systems for capturing, managing and processing diagnostic images and clinical/administrative information for hospitals and healthcare facilities, as well as contrast media solutions to enable effective medical imaging results.

Published by Agfa HealthCare NV
B-2640 Mortsel – Belgium
5U2KN GB 00201508