Porównanie systemów tomograficznych na podstawie danych podanych przez przedstawicieli firm do zapytania ofertowego
Część 3 – parametry jakości obrazowania

Comparison of the tomographic systems based on data provided by the company's representatives for the inquiry
Part 3 - image quality parameters

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Wprowadzenie

W artykule przedstawiono porównanie onkologicznych systemów tomograficznych czterech producentów, przeprowadzone w ramach realizacji zakupu na rzecz zakładu radioterapii. W tabeli zachowano zapisy/dane podane przez dostawców w oryginalnej formie. Jest to część druga, poświęcona parametrom jakości obrazowania – algorytmy akwizycji i rekonstrukcji, algorytmy/filtry redukcji/korekcji artefaktów, algorytmy/filtry kliniczne do obrazowania poszczególnych obszarów anatomicznych/

funkcjonalne, parametry jakościowe i ilościowe obrazów. Zestawienie tych danych pokazało, jak różnie rozumiane/zdefiniowane przez poszczególnych producentów mogą być zapisy/pytania o detale techniczne/parametry oraz jak różna jest metodologia prezentacji/wyrażania tych parametrów. Ostatecznie porównanie dla wielu parametrów z punktu widzenia oceny systemów TK na potrzeby zapytania ofertowego okazało się bardzo trudne. Porównanie przeprowadzono w 2014 roku. Ze względów technicznych część 3 porównania pozostała w oryginalnym zapisie w języku angielskim.

Streszczenie

W artykule przedstawiono porównanie onkologicznych systemów tomograficznych czterech producentów, przeprowadzone w ramach realizacji zakupu na rzecz zakładu radioterapii. W tabeli zachowano zapisy/dane podane przez dostawców w oryginalnej formie. Jest to część trzecia, poświęcona porównaniu funkcjonalności softwaru. Zestawienie tych danych pokazało, jak różnie rozumiane/zdefiniowane przez poszczególnych producentów mogą być zapisy/pytania o detale techniczne/parametry oraz jak różna jest metodologia prezentacji/wyrażania tych parametrów. Ostatecznie porównanie dla wielu parametrów z punktu widzenia oceny systemów TK na potrzeby zapytania ofertowego okazało się bardzo trudne. Porównanie zostało przeprowadzone w 2014 roku.

Słowa kluczowe: systemy tomograficzne, radioterapia, funkcjonalności software systemów TK

Abstract

The article will present a comparison of oncological CT systems of four manufacturers that were carried out for a business case of a purchasing procedure. The records/parameters/data in the table provided by the suppliers have been retained in an original form. It is the third part regarding a comparison of software modalities. The comparison of these parameters/data shows how the technical data/ specification/ records may be differently understood/defined by the particular manufacturers and how a methodology for presenting/expressing these parameters can be deferent. Finally, the comparison for many parameters from a CT systems evaluation point of view of was very difficult for the purpose of inquiry. The comparison was made in 2014.

Key words: CT systems, radiotherapy, CT software modalities

ZESTAWIENIE PARAMETRÓW SYSTEMÓW TK (WIDE BORE) – CZĘŚĆ 3

	ACQUISITION SOFTWARE		Yes
Acquisition clinical protocols: *oncology *pulmonology *colonoscopy *brain and multi-organs perfusion	All available	As standard, the Brilliance Big Bore is provided with all the necessary functionality to achieve these diagnostic examinations. The protocols are provided as standard and our applications specialists will provide full training if required.	The Definition AS 20/64 is supplied as standard with a range of protocols to perform and evaluate all types of diagnostic and RTP examinations including oncology, cardio thoracic, virtual endoscopy/colonography, vascular studies, neurology and perfusion. — Yes
Virtual endoscopy	Standard	Virtual Endoscopy functionality is provided as standard as a package on the CT Viewer programme. This is accessed on the second control-desk monitor.	Yes – see above
Angiography	Standard	As standard, the Brilliance Big Bore can acquire high-quality CT angiographic studies. Additional software to enable the quantification workups (stenosis measurements, stent planning etc) is available on a optional advanced processing workstations (IntelliSpace Portal IX). New Cross Radiology Department currently utilises the thin–client version of this workstation (IntelliSpace Portal HX) and the Brilliance Big Bore is fully compatible with this functionality. There will be no charge for connectivity to this workstation environment, however local agreement will be required.	Yes – see above
Fluoroscopy software and hardware	Low-dose interventional package (utilizing idose) comprising of ceiling mounted examination room monitor, dedicated protocols, a protected exposure foot-pedal and an interventional couch control joystick can be provided as an optional extra to the normal core configuration. Three modes are provided: CCT Single – a single 240° axial rotation (to protect clinicians hands if they remain in the bore) which reconstructs 4 contiguous images. The slice thickness can be changed by the user. CCT Continuous – a single 240° axial slice acquired concurrently at an inter-scan delay time specified by the user. CCT Fluoroscopy – real time axial slice reconstruction (8 frames per second). CT Fluoroscopy mode uses a 240° beam on rotation to protect the clinician's hands if they remain in the bore. Yes 2 options full fluoro (smartview) and step and shoot(smartstep) both available		The Definition AS 20/64 is supplied as standard with a full range of dedicated low dose interventional protocols. Interventional capability is offered based on client needs and can include an in-room monitor and footswitch (level 1) up to the 3D intervention suite including advanced interventional tools, wireless i-controller and dual monitors. — Yes
Synchronisation of acquisition start on the base inflow of contrast media analysis	BolusPro Ultra is provided and enabled as standard on all Philips CT scanners. This is a contrast monitoring program that allows placement of a ROI on aspecific vessel and intermittent monitoring scans (single slice in a static location) will commence after a pre-determined delay (user set in protocol). The interscan delay between monitor bursts can also be pre-programmed depending on the protocol. Once a pre-determined threshold is reached, the full diagnostic scan will automatically commence. It is possible to over-ride the function if the radiographer feels that the scan should begin sooner. During monitoring, the ROI will automatically compensate for patient / vessel movement and track the vessel as well as the contrast bolus. Yes available as an option.	Xtream Injector Interface, with validated OEM injectors, utilizes the CAN CiA425 communication protocol to provide synchronized start of the scan and injection from the CT Operator console or from the scan room. The Enhanced Xtream Injector Interface adds the ability to set the contrast injection parameters as part of the CT scan protocol from the console interface providing consistency of user entered parameters and reduction in the opportunity for error.	CARE Bolus (standard) CARE Contrast (costed option – injector of choice must be specified to ascertain compatibility). This software synchronizes scan and contrast injection and transfers the injector protocol data into the patient protocol, the e-logbook and to MPPS (if configured). — Yes

ACQUISITION SOFTWARE

Requirement	Description	Column 3	Column 4	Status
Software for automatic start-up of acquisition in the time of reaching required threshold CT number by contrast media in the vessel	BolusPro Ultra is provided and enabled as standard on all Philips CT scanners. This is a contrast monitoring program that allows placement of a ROI on a specific vessel and intermittent monitoring scans (single slice in a static location) will commence after a pre-determined delay (user set in protocol). The interscan delay between monitor bursts can also be pre-programmed depending on the protocol. Once a pre-determined threshold is reached, the full diagnostic scan will automatically commence. It is possible to over-ride the function if the radiographer feels that the scan should begin sooner. During monitoring, the ROI will automatically compensate for patient / vessel movement and track the vessel as well as the contrast bolus.	Smartprep contrast bolus chasing software is standard	CARE Bolus (standard)	Yes
Coupling CT system with contrast injector and management of it from main console	The Brilliance Big Bore CT System is provided with SAS (Spiral Auto Start) as standard. SAS functionality allows the scan acquisition or scan delay timer to commence following activation of the injector run. Management of the functionality is provided on the console, however management of the injector system remains at the injector console.	Complies optional	CARE Contrast (costed option – as above)	Yes
Automatic report for contrast media delivery parameters (after examination)	No – this is a functionality of the injector system.	With optional injector integration software	CARE Contrast (costed option – as above)	Dicom SR is supported with IEC3.0
Contras media bolus tracking	BolusPro Ultra is provided and enabled as standard on all Philips CT scanners. This is a contrast monitoring program that allows placement of a ROI on a specific vessel and intermittent monitoring scans (single slice in a static location) will commence after a pre-determined delay (user set in protocol). The interscan delay between monitor bursts can also be pre-programmed depending on the protocol. Once a pre-determined threshold is reached, the full diagnostic scan will automatically commence. It is possible to over-ride the function if the radiographer feels that the scan should begin sooner. During monitoring, the ROI will automatically compensate for patient / vessel movement and track the vessel as well as the contrast bolus.	Yes	CARE Bolus (standard)	Yes
Radiotherapy CT simulation software	Tumor LOC Simulator on Console – this is a unique feature on the Philips Brilliance Big Bore, which ensures that the system is a full CT simulator and not a Oncology optimised CT scanner. This package meets the clinical requirements of oncology departments where segmentation and localization can be completed directly on the CT display console. This can provide workflow flexibility and productivity in situations such as emergency simulations, "Sim and Treat", and simple simulation cases. The package provides tools to assist in Isocenter localization and CT Simulation. In addition to standard correlated studies, including all phase information. Visualization capabilities within the Tumor LOC	Yes Sim MD	**RT VSIM for MMWP (costed option)** *syngo*®-based virtual simulation software that optimizes the simulation process by accurately modeling all structures, radiation beams, and linear accelerator parameter and by producing high-quality DRRs, MPRs, MIPs, and surface shaded displays. It provides users with integrated viewing and imaging tools for diagnostic images including CT, MR, PET, and PET/CT. VSIM provides a navigational 3-D Rooms-eye-view graphic of the linear accelerator for treatment plan quality assurance and visualization of all relevant structures.	No

ACQUISITION SOFTWARE

package include the generation of Digitally Reconstructed Radiographs (DRR), Digitally Composited Radiographs (DCR), and Multiplanar reformatted images (MPR). Additionally, the package provides the ability to manage different window/level settings to aid in generating the best images possible. Special visualization tools for respiratory correlated scans are also included.

- Segmentation and localization.
- Efficient advanced contouring of external and critical structures in preparation for the radiotherapy treatment planning process.
- Visualization and analysis tools can be utilized to evaluate the treatment volume(s)
- Tools for visualizing and analyzing respiratory correlated datasets (4D)

Simulation capabilities include:
• Multiple radiotherapy machine characterizations
• Visualization and analysis of multiple treatment beams
• Beam modifiers such as blocking and MLC capabilities

Features and capabilities provided by the Brilliance CT Tumor LOC software include:

Contour-Based Segmentation Package: Consists of drawing and editing tools for drawing contours and maintaining groups of contours used in hand segmenting image data. Tools also exist for interpolation functions for automatic and semi-automatic segmentation. Automated generation of an external contour can be preselected as a user defined preset.

Virtual Fluoroscopy using orthogonal beam divergent DRR's for isocenter and beam border placement.

Interpolate algorithm provides interactive, shape based interpolation. A Smart algorithm fills in any number of irregularly contoured slices, Interpolated contours may be edited, accepted or rejected.

Isocenter Management:
Isocenter menu to support and manage multiple isocenters. Supports the generation of separate isocenters for multiple target volumes or general regions. Marked and final Isocenters are reported and displayed in the Localization package for easy confirmation of a physical simulation session. A record of the simulation session may be printed on a standard printer. If configured, RT Plan can easily be exported to the laser system for a more streamlined marking procedure.

Isocenters and structure sets can be transmitted to a compatible RTP System capable of receiving DICOM RT structure set, plan, and RT Image.

2D Image Analysis: Enables viewing of the data exactly as it was acquired, prior to any interpolation and with no preprocessing.

ACQUISITION SOFTWARE

Markers: Permits the display of a fixed marker (cross hairs, axis or grid) on the screen as an aid in isocenter marking, or image positioning.
Screen Annotation: Allows the operator to toggle selected screen annotations on and off.
Archive: Allows the user to archive a patient study from disk onto selected archive media.
Information: Displays the study's original scan information, including the number of slices in the study, slice thickness, etc. Can be displayed at any time during an analysis.
Control of Window/Level: Allows adjustment to achieve optimal viewing parameters.
Measurement Package: Provides the density value (in Hounsfield units if CT) of a particular point on an image. Computes distances along straight lines.
Pan: Permits the repositioning of any image within a viewport.
Tools to allow visualization of organ motion and to assist physician in determining best treatment are the following:
Import of multiple phase datasets as well as a routine CT

Contour on any phase and apply it to a chosen primary phase
Dynamic DRR/DCR
Dynamic MPR & Axial
Maximum, minimum, and average intensity projection dataset generation

Prospective triggering system software

The Brilliance Big Bore is equipped with the ability to perform both prospective and retrospective gated acquisitions as standard. It is supplied with a bellows device (pressure transducer) worn around the patients abdomen to acquire the breathing waveform which is then used to either trigger the X-Ray exposure (in prospective mode), or to determine the data amplitude/phase locations (in 4D Respiratory Correlated mode). The user has the ability to edit the waveform after acquisition to reduce artefacts in the images caused by coughs etc. The scanner/supplied software are also compatible with third party solutions such as the Varian RPM device.

Once acquired, the resultant 4D dataset can be loaded into the Tumor LOC software supplied on the system and converted into timed MIPs (maximum intensity projections), timed MinIPs and timed average datasets. These reconstructed datasets can then be exported to the planning system for contouring and dose calculations.

Uniquely the Philips Brilliance Big Bore supports both phase (time) and amplitude binning of 4D data. As the VarianRPM is amplitude based this ensures maximum accuracy with 4D treatment delivery.

Yes prospective respiratory gating available

Respiratory Gating and Triggering (costed option)
This package is comprised of software components that allow the capture and storage of a signal representing a patient's respiratory cycle during a spiral or sequence CT acquisition.
With the Respiratory Gating feature, the respiratory data is synchronized with the CT acquisition data so that a user can freely select the point at which images are retrospectively reconstructed based on the corresponding respiration amplitude. With the Respiration Triggering feature, the user prospectively selects a point in the respiratory cycle at which sequence images will be acquired.
This option is supplied with an OPEN Interface kit to connect to an external respiratory device (external respiratory device is NOT supplied).
For best visualisation of 4D data sets we recommend InSpace 4D for MMWP (costed option).
InSpace 4D provides interactive, real-time 3D and 4D viewing functionality using volume rendering techniques, and is suited particularly to radiologists for online diagnosis.
Heartview CT, ECG triggering/gating for cardiac studies, is also available as the Definition OPEN is a diagnostic level CT scanner.

Yes

ACQUISITION SOFTWARE

Retrospective gating software	The Brilliance Big Bore is equipped with the ability to perform both prospective and retrospective gated acquisitions as standard. It is supplied with a bellows device (pressure transducer) worn around the patients abdomen to acquire the breathing waveform which is then used to either trigger the X-Ray exposure (in prospective mode), or to determine the data amplitude/phase locations (in 4D Respiratory Correlated mode). The user has the ability to edit the waveform after acquisition to reduce artefacts in the images caused by coughs etc. The scanner/supplied software are also compatible with third party solutions such as the Varian RPM device. Once acquired, the resultant 4D dataset can be loaded into the Tumor LOC software supplied on the system and converted into timed MIPs (maximum intensity projections), timed MinIPs and timed average datasets. These reconstructed datasets can then be exported to the planning system for contouring and dose calculations. Uniquely the Philips Brilliance Big Bore supports both phase (time) and amplitude binning of 4D data. As the VarianRPM is amplitude based this ensures maximum accuracy with 4D treatment delivery.	Yes retrospective respiratory gating available	Yes
Virtual simulation module/software	Tumor LOC – please see above for explanation.	Sim MD	See above for details
4D reconstruction algorithm/software	Uniquely the Philips Brilliance Big Bore supports both phase (time) and amplitude binning of 4D data. As the VarianRPM is amplitude based this ensures maximum accuracy with 4D treatment delivery.	Advantage 4D	RT VSIM for MMWP (costed option – see above) · MMWP RT4D Advanced package (costed option – requires concurrent purchase of VSIM for MMWP)

RT VSIM for MMWP (costed option – see above)

MMWP RT4D Advanced package (costed option – requires concurrent purchase of VSIM for MMWP)

syngo® TrueD (including TrueD Basic, RT Structure Creation and Gating Visualization) syngo TrueD enables physicians to efficiently compare patient scans from up to three different time points (e.g., pre- and post-therapy plus 12 month follow-up). The application can display multiple studies on the same screen at the same time or spread across two monitors in compare mode layouts.

Quantitative analysis of a lesion in terms of volume, HU level and average and peak SUV values are done simultaneously by linking the two or three studies which are loaded, to assess changes in lesion number, activity and size, often for evaluation of therapeutic response. It also provides the ability to store VOIs (volumes of interest) created as part of the evaluation of PET.CT datasets as DICOM RT Structured Sets for exporting them to radiation therapy planning systems (RTP). These can be used for RT simulation and planning in order to eliminate additional processing requirements and improve planning accuracy.

It also provides the capability to load and visualize PET and CT respiratory acquired gated data sets. Visualization of cine loops of individual datasets as well as individual frames within each gate is possible along with cine display
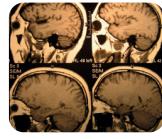
Can be supplied as part of a separate radiotherapy planning system

Can be supplied as part of a separate radiotherapy planning system

ACQUISITION SOFTWARE

of fused gated data. Contours can now also be created on the gated images and propagated through other gates. A superset of those contours can be created for the final ITV. Additionally, a single gate within a study can be loaded along side a gated study and contours can be drawn on the individual gate.

The application also incorporates a unique set of easy-to-use reporting tools.

The integrated editing package allows segmentation of 3D datasets either with manual contour creation, thresholding, or volume growing operations. Dataset confinement is possible either using a ClipBox or a variable editing slab. Image quality can be improved with morphological operators such as Erosion and Dilatation. Fusion of separately acquired PET and CT studies is also possible with automated fusion algorithms as well as manually, using multiple planes. It also includes e-learning for TrueD. With the included e-learning, the user is introduced to the syngo TrueD workflow and the multiple possibilities of this software application.

Can be supplied as part of a separate radiotherapy planning system	See RT4D advanced package above
	Yes with Advantage 4D and AW Sim
	This is a standard functionality on the Tumor LOC programme.
	4D contouring software