ziehm imaging

Dose comparison between Ziehm Vision RFD 3D and Medtronic O-arm® O2

Discover significantly lower dose levels for the Ziehm Vision RFD 3D.

Today, intraoperative 3D imaging is regarded as the gold standard in complex, minimally invasive surgeries. Especially in sensitive areas such as the cervical spine, or even in complex orthopedic and trauma surgeries, reliable intraoperative imaging is essential for the safe placement of implants and the immediate control of results.

At the same time, dose exposure is being increasingly discussed in our industry and in daily communication with customers and healthcare professionals. Organizations such as the International Commission on Radiology Protection (ICRP), the European ALARA Network, the American Association of Physicists in Medicine (AAPM) and Image Gently are instrumental in recognizing the importance of dose management and appropriate treatment.

This paper is a compilation of dosimetry measurements on two major current mobile 3D imaging technologies.

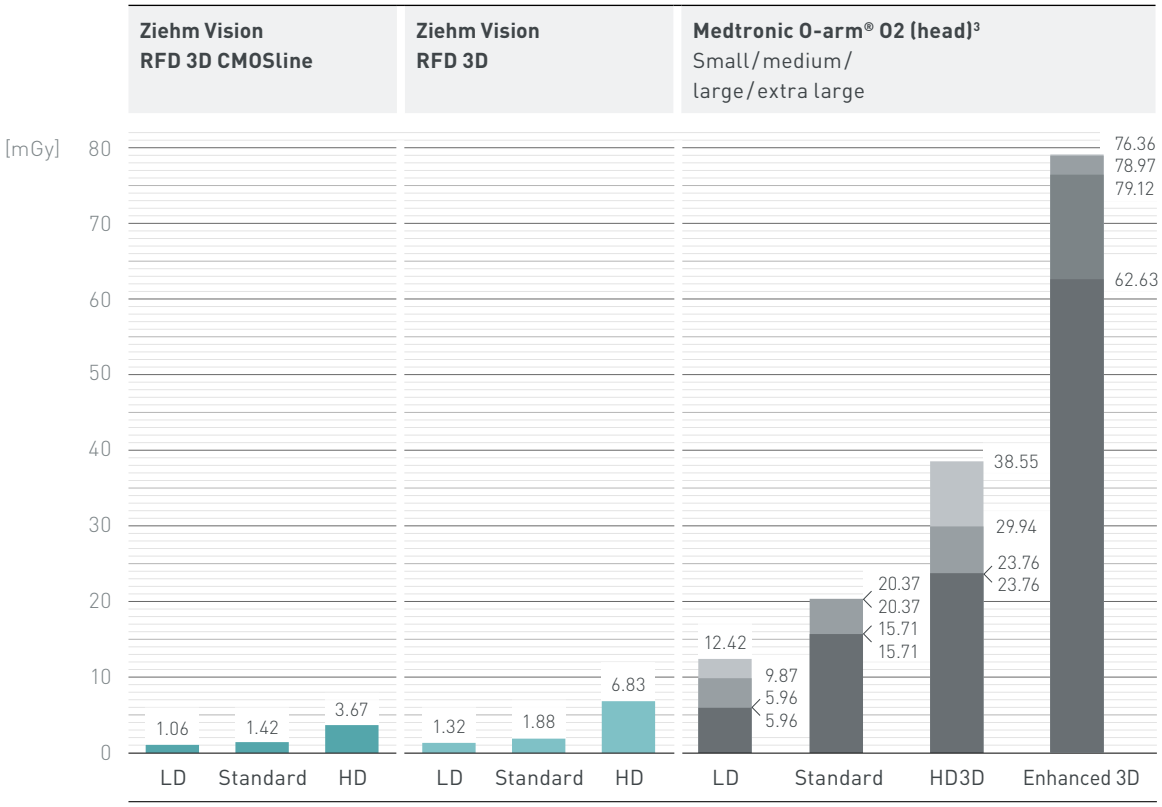
Current situation

With the trend toward minimally invasive surgeries, the demand for intraoperative 3D imaging has gained relevance during the last decade to enable real-time imaging information within the operating theater and to be able to refer to the current anatomical situation. It has also become more important to control the placements of implants intraoperatively to reduce the need for revision surgeries.

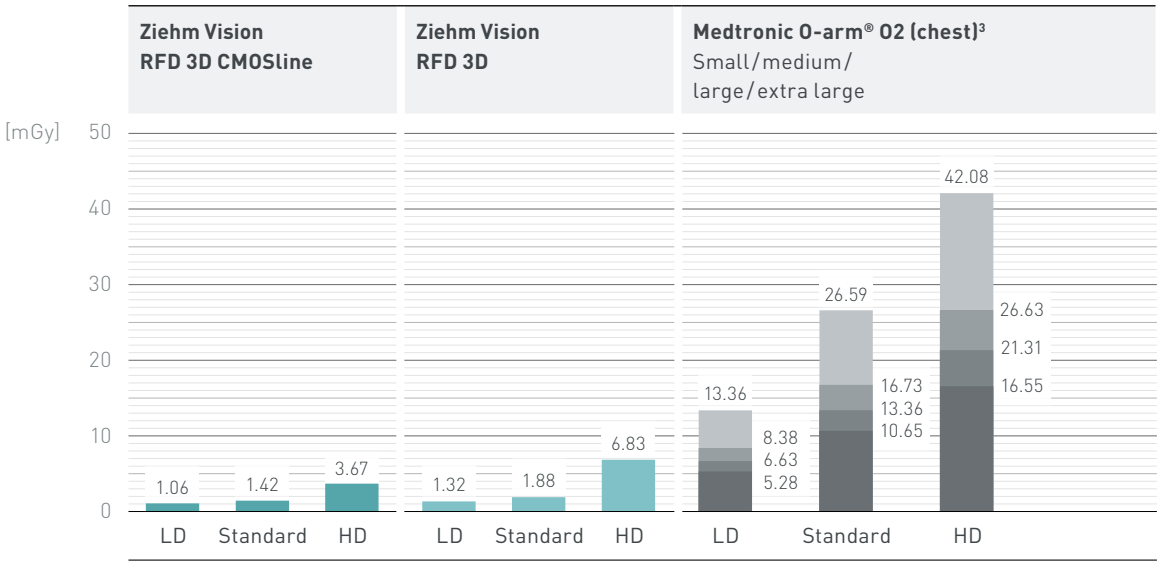
Dosimetry results

The following CTDI comparison of the Ziehm Vision RFD 3D, the enhanced Ziehm Vision RFD 3D CMOSline[1] and Medtronic O-arm® O2 provides a dose index for different applications. The following tables show the CTDI in mGy for the different applications named in each headline. The CTDI values were measured/calculated with the cylindrical PMMA phantom with two different diameters (32 cm, 16 cm).

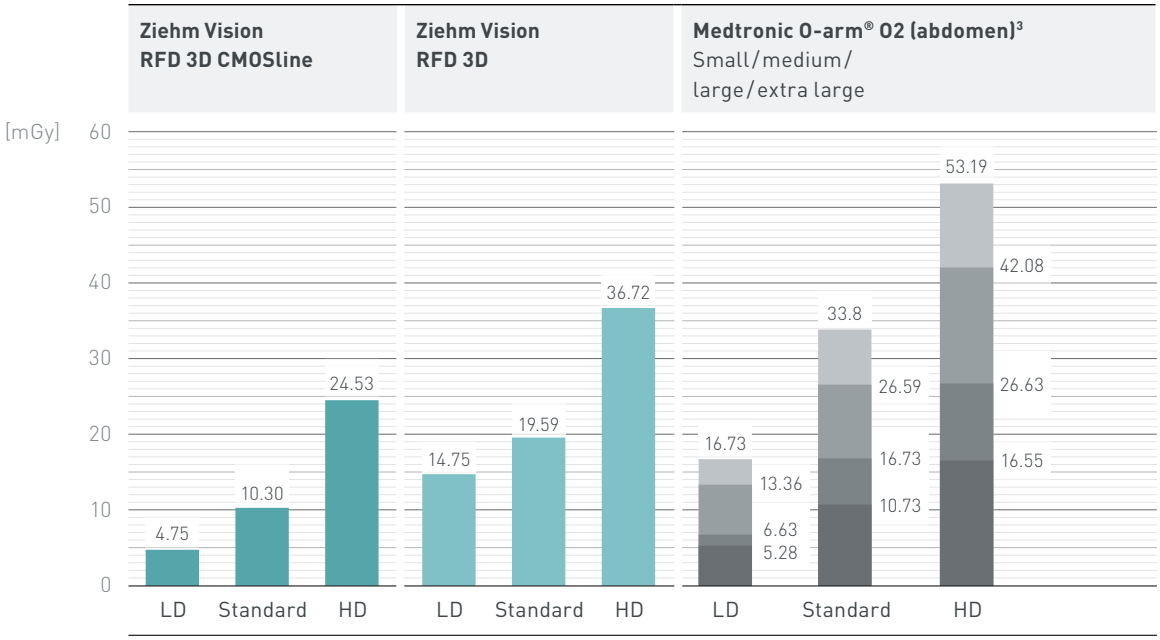
a. Dosimetry data for head protocols (16 cm CTDI phantom)



b. Dosimetry data for cervical spine (16 cm CTDI phantom)



c. Dosimetry data for lumbar spine/pelvis protocols (32 cm CTDI phantom)



d. Dosimetry data for extremities (16 cm CTDI phantom)

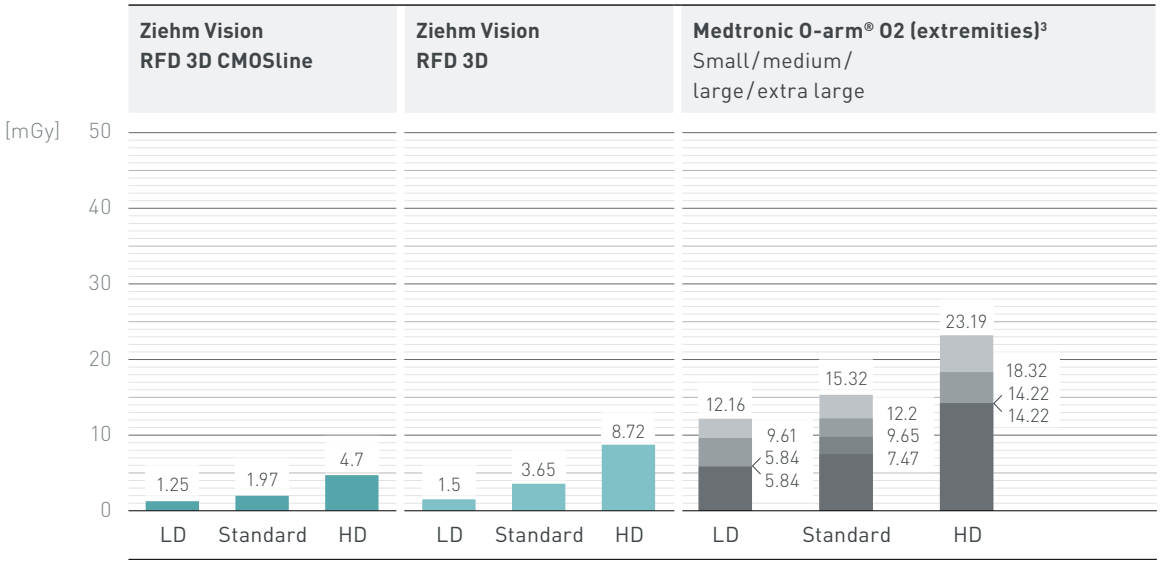


Image quality results

In addition to the dosimetry comparisons based on physical conditions, we also managed to achieve an exemplary image quality comparison with an anthropomorphic X-ray head phantom for high-contrast imaging. For those high-contrast procedures, the differentiation between metal, bone and soft tissue is pivotal. The following images show the image quality of the two different systems. Image captures show the dose results of the measurements for the 16 cm CTDI phantom.

Ziehm Vision RFD 3D CMOSline (head, resolution 512^3 voxel)

Low Dose, $CTDI_{vol16}$ 1.06 mGy

Standard, $CTDI_{vol16}$ 1.42 mGy

HD, $CTDI_{vol16}$ 3.67 mGy

Medtronic O-arm® O2 (head, resolution 512 x 512 x 192 voxel)

Low Dose, small, $CTDI_{vol16}$ 5.96 mGy

Standard, medium, $CTDI_{vol16}$ 15.71 mGy

HD 3D, medium, $CTDI_{vol16}$ 23.79 mGy

Dosimetry comparison

For the first time, we are able to compare standardized measurements with the PMMA phantom and standardized measurement setups for the Ziehm Vision RFD 3D, the Ziehm Vision RFD 3D CMOSline and Medtronic O-arm® O2. This makes it possible to eliminate patient variability, which usually influences dose levels the most. The systems from Ziehm Imaging in particular offer an intelligent, real-time dose regulation that is influenced by different patient anatomy and constitution. The setup with a standardized PMMA phantom makes a real comparison possible.

1. The dose measurements comparing three systems clearly depict the profound advantage of the Ziehm Vision RFD 3D and the Ziehm Vision RFD 3D CMOSline.

2. Ziehm Imaging is strongly driving the awareness of ALARA principles in the industry and among customers. That is why the Low Dose mode is set as the default mode for all Ziehm Imaging systems.

3. The Ziehm Vision RFD 3D and the Ziehm Vision RFD 3D CMOSline show advantages in all cases compared with Medtronic's O-arm® O2 depending on the specialized patient program of the O-arm® O2. By comparing only the lowest possible CTDI values in each program of Medtronic with the CTDI values of the Ziehm Vision RFD 3D and the Ziehm Vision RFD 3D CMOSline, the C-arms show better results in 51 of 52 available cases.[4]

Image quality comparison

The images show clearly that both systems offer a comparable image quality and allow a clear differentiation of finest bone structures to soft tissue in the head. Furthermore, boundaries between cortical bone structures and the cancellous bone can also be differentiated as well as hollow spaces in the sinus cavity.

The high-contrast characteristic is provided by both systems, but variations between image impression and homogeneity arise from different dose levels. Comparing the dose levels of those two exemplary phantom image series, the data shows that comparable image quality does not result in comparable dose levels ($CTDI_{vol16}$ value for standard 3D mode[5]: Ziehm Vision RFD 3D CMOSline: 1.42 mGy; Medtronic O-arm O2: 15.71 mGy). As a result, the conclusion can be drawn that the Ziehm Vision RFD 3D CMOSline works strictly according to ALARA principles, offering sufficient image quality at the lowest possible dose[6].

Conclusion

The Ziehm Vision RFD 3D offers unprecedented performance across the most varied and challenging application spectrum and can be seen as one of the most important and dose-saving alternatives in the field of mobile intraoperative 3D imaging systems. In addition, the Ziehm Vision RFD 3D CMOSline comes with an enhanced version of our comprehensive SmartDose Concept. A newly developed dose-saving technology called Beam Filtration[7] supports the latest improvements in our enhanced CMOS imaging chain, thus enabling an exceptional reduction in the skin entrance dose. As a result, the Ziehm Vision RFD 3D CMOSline delivers excellent image quality with a lower dose, which is also confirmed by our customers:

"Compared with systems with comparable image quality such as Medtronic's O-arm, the Ziehm Vision RFD 3D has superior OR usability and advanced radiation dose control, which benefits patients, surgeons and staff alike. The excellent image quality results in increased patient safety. In addition, the ideal usability gives improved surgeon efficiency. Ziehm Imaging's dramatically superior price-performance ratio allows radiology purchasing decision-makers to get this

technology in the hands of doctors and realize immediate return on investment," said S. Raymond Golish, MD PhD MBA, Chief Quality Officer at Jupiter Medical Center in Palm Beach, Florida, USA.

Authors:
Lena Blaschka
Global Product Manager 3D & Navigation
Ziehm Imaging GmbH

Anne-Kathrin Meier
Senior Clinical Marketing Manager
Ziehm Imaging GmbH

Günter Stelzer
Director Special Projects (retired)
Ziehm Imaging GmbH

Kevin Packard
Strategic Clinical Marketing Manager
Stryker

Updated by:
Thomas Held
Global Product Manager 3D
Ziehm Imaging GmbH

Dorian Fredrich
Global Marketing Manager
Ziehm Imaging GmbH

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[1] CMOSline represents a system configuration that is based on a Ziehm Imaging CMOS flat-panel detector.

[2] For more information about data acquisition method, measurement equipment and measurement set-up, please refer to the long version of this paper. For download please click here.

[3] The programs and settings used were in accordance with the respective manufacturer's recommendations for the applied applications.

[4] Case means patient modifier in a protocol with different patient size; 3 protocols including 3 modifier à 4 patient sizes (cervical spine protocol, spine/pelvis protocol, extremities protocol with modifier Low Dose, Standard, HD in the patient sizes small, medium, large and extra large) and 1 protocol including 4 modifier à 4 patient sizes (head protocol with modifier Low Dose, Standard, HD3D and Enhanced 3D in the patient sizes small, medium, large and extra large) result in 52 cases.

[5] It can be assumed that the absorption with a 16 cm PMMA CTDI phantom adequately represents the head phantom.

[6] Based on a clinical evaluation for the anatomical program Head, see chapter "Image quality results". Data on file, results may vary.

[7] The technology Beam Filtration reduces dose exposure for all CMOSline systems in comparison with conventional filtration techniques (status before September 2017). Data on file. Results may vary.