Photon-counting detector CT – first experiences in the field of musculoskeletal radiology

Photon-Counting Detektor CT – Erste Erfahrungen im Bereich der muskuloskelettalen Bildgebung

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ABSTRACT

Background The introduction of photon-counting detector CT (PCD-CT) marks a remarkable leap in innovation in CT imaging. The new detector technology allows X-rays to be converted directly into an electrical signal without an intermediate step via a scintillation layer and allows the energy of individual photons to be measured. Initial data show high spatial resolution, complete elimination of electronic noise, and steady availability of spectral image data sets. In particular, the new technology shows promise with respect to the imaging of osseous structures. Recently, PCD-CT was implemented in the clinical routine. The aim of this review was to summarize recent studies and to show our first experiences with photon-counting detector technology in the field of musculoskeletal radiology.

Methods We performed a literature search using Medline and included a total of 90 articles and reviews that covered recent experimental and clinical experiences with the new technology.

Results and Conclusion In this review, we focus on (1) spatial resolution and delineation of fine anatomic structures, (2) reduction of radiation dose, (3) electronic noise, (4) techniques for metal artifact reduction, and (5) possibilities of spectral imaging. This article provides insight into our first experiences with photon-counting detector technology and shows results and images from experimental and clinical studies.

Key Points

- This review summarizes recent experimental and clinical studies in the field of photon-counting detector CT and musculoskeletal radiology.
- The potential of photon-counting detector technology in the field of musculoskeletal radiology includes improved spatial resolution, reduction in radiation dose, metal artifact reduction, and spectral imaging.
- PCD-CT enables imaging at lower radiation doses while maintaining or even enhancing spatial resolution, crucial for reducing patient exposure, especially in repeated or prolonged imaging scenarios.
- It offers promising results in reducing metal artifacts commonly encountered in orthopedic or dental implants, enhancing the interpretability of adjacent structures in postoperative and follow-up imaging.
- With its ability to routinely acquire spectral data, PCD-CT scans allow for material classification, such as detecting urate crystals in suspected gout or visualizing bone marrow edema, potentially reducing reliance on MRI in certain cases.

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ZUSAMMENFASSUNG

Hintergrund Mit Einführung der Photon-Counting Detektor CT (PCD-CT) vollzieht sich ein bemerkenswerter Innovationssprung in der CT-Bildgebung. Die neue Detektor-Technologie ermöglicht es, Röntgenstrahlen ohne Zwischenschritt über eine Szintillatorschicht direkt in ein elektrisches Signal umzuwandeln und die Energie einzelner Photonen zu messen. Erste Daten zeigen eine hohe Ortsauflösung, eine vollständige Elimination des elektronischen Bildrauschens und die stetige Verfügbarkeit spektraler Bilddatensätze. Insbesondere in der Bildgebung ossärer Strukturen zeigt die neue Technologie vielversprechende Ansätze. Seit ca. 3 Jahren wird die PCD-CT bereits in der klinischen Routine angewandt. Ziel dieser Übersichtsarbeit ist es, einen Überblick über aktuelle Studien und unsere ersten Erfahrungen mit der Photon-Counting Detektor-Technologie im Bereich der muskuloskelettalen Bildgebung zu geben.

Methode Es erfolgte eine Literaturrecherche auf „Medline“. Eingeschlossen wurden insgesamt 90 Übersichtsarbeiten und Originalarbeiten, die erste experimentelle oder klinische Erfahrungen mit der neuen Technologie zeigen.

Ergebnisse und Schlussfolgerung Die Übersichtsarbeit fokussiert sich insbesondere auf (1) die Ortsauflösung und Abgrenzbarkeit kleiner anatomischer Strukturen, (2) die Reduktion der Strahlendosis, (3) das Bildrauschen, (4) Techniken zur Reduktion von Metallartefakten und (5) die Möglichkeiten der spektralen Bildgebung. Der Artikel gibt zudem Einblicke in unsere ersten klinischen Erfahrungen und zeigt die Ergebnisse und Bilder aus experimentellen und klinischen Studien.

Kernaussagen

- Diese Übersicht fasst aktuelle experimentelle und klinische Studien im Bereich Photon-Counting Detektor CT (PCD-CT) und muskuloskelettaler Bildgebung zusammen.
- Die PCD-Technologie hat das Potential der Verbesserung der Ortsauflösung, der Reduktion von Strahlendosis und Metallartefakten sowie einer spektralen Bildgebung bei jeder Untersuchung.
- Die PCD-CT ermöglicht eine gleichbleibende bzw. teils sogar verbesserte Ortsauflösung bei niedrigeren Strahlendosen; dies ist entscheidend für die Reduktion der Strahlendosis, insbesondere bei Patientinnen und Patienten, die regelmäßige CT-Untersuchungen erhalten.
- Die PCD-CT zeigt vielversprechende Ergebnisse in der Reduktion von Metallartefakten, beispielsweise bei Metallimplantaten in Hüfte, Wirbelsäule oder in den Zähnen; dies verbessert die Beurteilbarkeit der umliegenden Strukturen.
- Mit der Möglichkeit, routinemäßig eine spektrale Bildgebung zu akquirieren, können in PCD-CT Untersuchungen beispielsweise Urat-Kristalle bei Verdacht auf Gicht dargestellt werden. Neue Studien zeigen auch das Potential der Darstellung eines Knochenmarködems; somit könnte ggf. auf weitere Untersuchungen (z. B. MRT) verzichtet werden.

Background

In the 1970 s, the first computed tomography (CT) scanner was implemented in the clinical routine. During the past decades, many innovations have continuously improved CT imaging. Conventional multi-slice detector CT (MDCT) in clinical routine is typically equipped with *energy-integrating* detectors (EID). Images result from indirect conversion of X-ray photons into visible light and then into an electric signal [1, 2, 3]. By integrating the absorbed energy over a short period of time, the information from each individual X-ray photon's energy is lost [4].

New CT scanners use photon-counting detectors (PCD). In contrast to EID, PCDs are able to directly convert X-ray photons into an electric signal using semiconductors [5]. Based on this groundbreaking technology, PCD-CT can overcome many limitations of EID-CT. The main advantages of PCD-CT are the elimination of electronic noise, the improvement of spatial resolution, the intrinsic spectral imaging capabilities, and the potential reduction of radiation dose [2, 3, 5, 6, 7, 8].

PCD-CT was introduced in clinical routine in April 2021. Two PCD systems are currently used: a commercially available system (Naeotom Alpha, Siemens Healthineers, Erlangen, Germany) and a clinical prototype (SPCCT, Philips GmbH, Hamburg, Germany). Most studies that are covered by this review and also our personal experiences focus on the former.

The aim of this review was to summarize the first experimental and clinical experiences with PCD-CT in musculoskeletal radiology.

Methods

We performed a literature search using Medline and the keywords "photon-counting detector", "bone", "musculoskeletal", "ultra-high resolution", "radiation dose", "metal artifact". Articles were included if they covered experimental (including phantom studies and cadaveric studies) and first clinical results in the field of musculoskeletal radiology. ▶ **Table 1** summarizes the articles from this review categorized according to the body region, experimental or clinical study, and the number of subjects included in the study. All details of the original articles that were cited in this review are summarized in **Supplemental Table 1**.

For each subsection we also included our first experimental and clinical experiences and added images generated at our institution, where appropriate.

▶ **Table 1** Summary of included articles.

Subject	Number of articles	Total number of patients	Main topics
Reviews	13	n.a.	▪ Technical principles and clinical benefits of PCD-CT ▪ First clinical experiences with PCD-CT ▪ Bone marrow edema ▪ Metal artifact reduction
Abdomen	2	150	▪ Delineation of liver lesions using VMI and quantum iterative reconstruction methods
Dental imaging	1	n.a.	▪ Detection of apical osteolysis
Extremities	9	12	▪ Improved visualization on PCD-CT compared to EID-CT ▪ Reduced radiation dose on a PCD-CT scanner compared to an EID-CT scanner
Head	7	51	▪ Improved delineation of the skull base and temporal bone on PCD-CT compared to EID-CT
Heart	3	100	▪ Delineation of coronary lumen and quantification of coronary plaques on PCD-CT
Lung	6	295	▪ Improved visualization of lung structures using UHR-mode on a PCD-CT scanner compared to an EID-CT scanner
Multiple myeloma/ metastases	5	90	▪ Superior delineation of myeloma lesions and metastases on PCD-CT compared to EID-CT
Multiple regions	7	75	▪ Improved spatial resolution and reduced radiation dose on a PCD-CT scanner compared to an EID-CT scanner
Spine	6	71	▪ Improved visualization and reduced radiation dose on a PCD-CT scanner compared to an EID-CT scanner
Bone marrow edema – DECT	7	448	▪ DECT for the detection of bone marrow edema with a focus on scaphoid fractures, undisplaced hip fractures, and vertebral fractures
Spectral imaging	5	n.a.	▪ Spectral decomposition techniques in bone and joint imaging
Metal artifact reduction	19	369	▪ Different techniques for metal artifact reduction including IMAR, MAR, and VMI

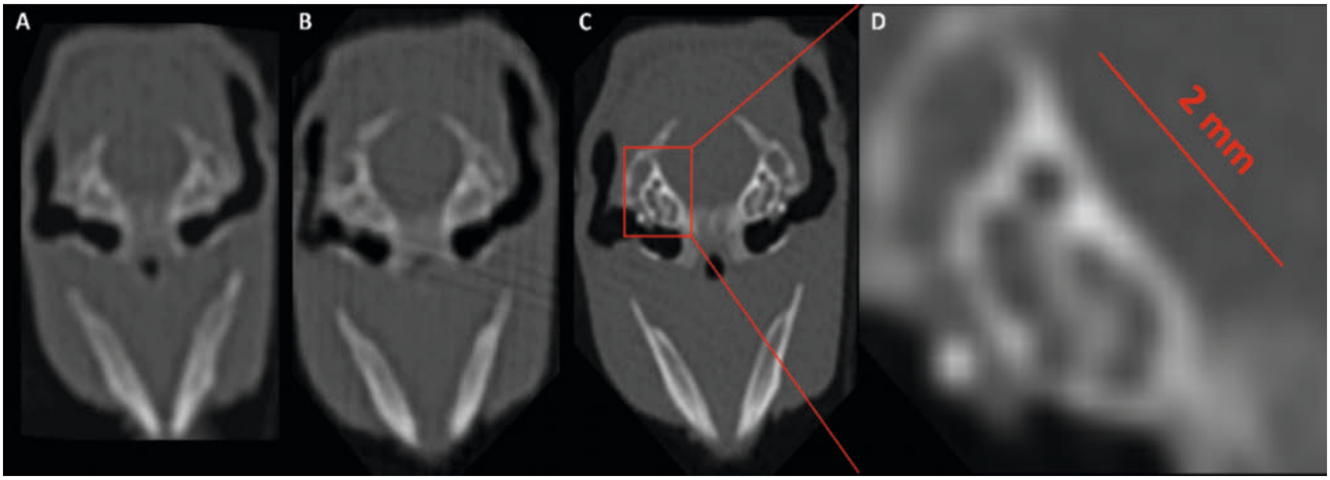
DECT: dual-energy CT; EID-CT: energy-integrating detector CT; IMAR: iterative metal artifact reduction; MAR: metal artifact reduction; PCD-CT: photon-counting detector CT; VMI: virtual monoenergetic images

Results

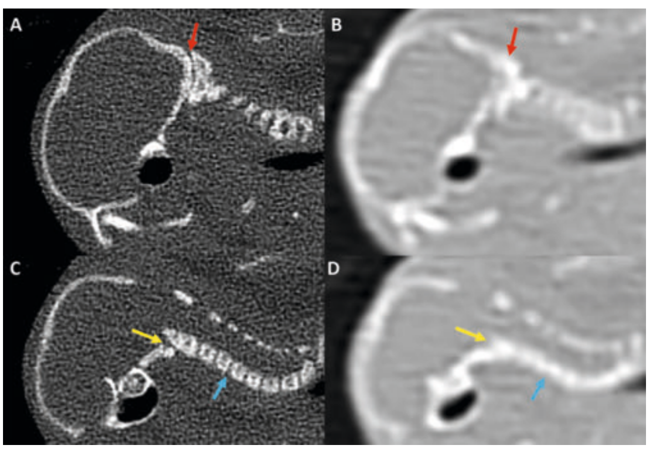
Improved spatial resolution and reduction of radiation dose

Due to the ability to directly convert X-ray photons into an electric signal and the use of smaller detector pixels, PCDs exhibit (ultra-) high resolution capabilities [9]. Especially in bone imaging, high spatial resolution is important for the imaging of fractures, bone healing, malignancies, and the visualization of tiny osseous structures [9]. Previous cadaveric studies have demonstrated the higher spatial resolution of PCD-CT compared to EID-CT [2, 3, 10, 11]. Recent studies also highlighted the higher spatial resolution even with a lower radiation dose on a PCD-CT scanner compared to an EID-CT scanner [12, 13, 14, 15]. Regarding specific body regions, previous phantom/mouse and cadaveric studies pointed out the improved visualization and delineation of tiny bone details in the following anatomical regions: shoulder [16], wrist [12, 17], temporal bone and skull base [13, 15], appendicular skeleton [18], spine [15, 19, 20, 21], paranasal sinus [22], and elbow [23]. Especially ultra-high resolution reconstructions have the ability not only to improve visualization of lung structures [24, 25, 26, 27, 28, 29, 30] and cardiac structures [31, 32, 33, 34], but also of bones [11, 12, 13, 15, 16, 20, 35, 36, 37, 38, 39, 40, 41].

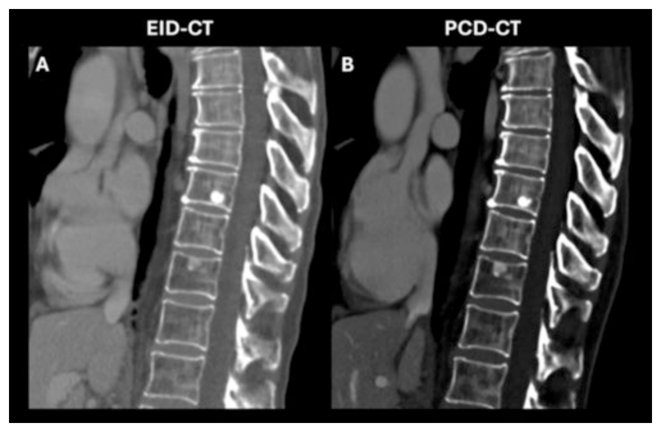
For example, using a mouse model, intervertebral spaces of the cervical spine were visible on PCD-CT at a radiation dose of 5 mGy $CTDI_{vol}$ (computed tomography dose index volume), while a dose of 20 mGy $CTDI_{vol}$ was necessary to discriminate different vertebrae on EID-CT. However, delineation was still unsharp. To clearly visualize the skull base and the inner ear of a mouse, 10 mGy $CTDI_{vol}$ was sufficient on PCD-CT, whereas sharp delineation was not possible on EID-CT even at 20 mGy $CTDI_{vol}$ [15]. ▶ **Fig. 1** shows an example of ultra-high resolution imaging of the skull base of a mouse on different CT scanners, highlighting the capability of PCD-CT to provide sharp resolution of even tiny bone structures. In ▶ **Fig. 2** we provide a comparison between PCD-CT and EID-CT at a radiation dose of 20 mGy $CTDI_{vol}$. This example highlights the improved spatial resolution and detailed visualization of small bone structures. Using an ultra-sharp reconstruction kernel (Hr98) on the PCD-CT scanner, the craniocervical junction, the atlantodental space, and also the intervertebral disc were clearly visualized in a mouse model. The higher spatial resolution on PCD-CT was also shown quantitatively; our group assessed the edge sharpness at the lumbar and cervical spine. On a



► **Fig. 1** Ultra-high resolution imaging of the skull base of a mouse on an EID-CT scanner (**A**: 20-slice EID-CT, **B**: 64-slice EID-CT), and on a PCD-CT scanner (**C**). Image **C** shows the remarkably sharp visualization of tiny structures of the skull base with a size of only about 2 mm.



► **Fig. 2** Ultra-high resolution imaging of a mouse in comparison between a 20-slice EID-CT image (**B, D**) and PCD-CT image (**A, C**), both at 20 $CTDI_{vol}$. Image A shows the sharp delineation of the atlantooccipital joint (red arrow) on a PCD-CT scanner. In image **C**, the delineation of the atlantodental space (yellow arrow) and the intervertebral discs (blue arrow) is highlighted, whereas on an EID-CT image (**B, D**) the described structures cannot be visualized clearly.



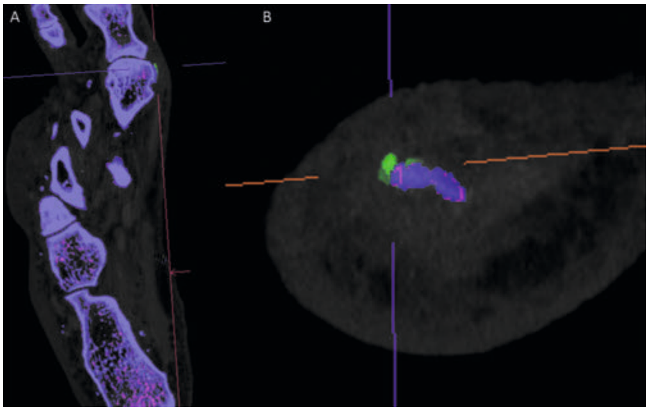
► **Fig. 3** Example of a patient with bone metastases from breast cancer and short-term follow-up on an EID-CT image (**A**) and a PCD-CT image (**B**) which allows a direct comparison of both scanners in the delineation of critical findings such as metastases.

PCD-CT scanner, edge sharpness was significantly higher compared to an EID-CT scanner in all analyzed regions [15]. Similar results with higher cortical sharpness were also reported by Sonnow et al. using a cadaver study with an artificially created elbow fracture [23].

First clinical studies confirmed that spatial resolution is higher on a PCD-CT scanner compared to an EID-CT scanner in musculoskeletal imaging. For example, Benson et al. showed improved delineation of temporal bone compared to EID-CT [42], Rajagopal published the first clinical results in skull base imaging [43], while Baffour et al. showed results of imaging of the pelvis and shoulder [36]. Rajendran et al. shared the first results for wrist imaging [35] and Rau et al. showed improved spatial resolution for PCD-CT in spine imaging [44]. A recently published study by Marth et al. showed comparable image quality of the lumbar spine on PCD-CT (compared to EID-CT) at significantly lower radiation doses [45].

New image reconstruction techniques including iterative reconstruction can further improve the spatial resolution of reconstructions in PCD-CT [9, 29, 46].

The first clinical studies also addressed the diagnostic performance of PCD-CT for the detection of malignant bone lesions, e. g., myeloma [47]. Recent studies in patients with myeloma showed similar lesion detection on PCD-CT compared to EID-CT, however, with a lower radiation dose [48], improved spatial resolution, and visibility on PCD-CT compared to EID-CT [49, 50]. Wherse et al. reported improved visualization of bone metastases using ultra-high resolution kernels on an experimental PCD-CT scanner in a case series of breast cancer patients [51]. ► **Fig. 3** shows an example of a patient with bone metastases of breast cancer with CT scans on a PCD-CT scanner and on an EID-CT scanner (time frame about three months between the two examinations), allowing a



▶ **Fig. 4** Spectral imaging in the diagnostic work-up of suspected gout. Image **A** shows tiny urate crystals (green) next to the metocarpophalangeal joint. In **B**, the joint is magnified and shown in sagittal reconstructions. Image B points out the possibility of PCD-CT to visualize and locate very tiny urate crystals.

direct comparison of both scanners. These images highlight the improved spatial resolution of PCD-CT for the delineation of critical findings, e. g., bone metastases.

Exploiting the ability of PCD-CT to improve spatial resolution and to reduce image noise, it has a high potential to reduce patients' radiation dose. Our first experimental studies showed the possibility to detect tiny bone structures on PCD-CT with a lower $CTDI_{vol}$ compared to EID-CT [15]. In musculoskeletal imaging, low-dose CT protocols are important for the detection of bone lesions, especially in patients with the need for repeated CT imaging [9].

Promising results for radiation dose reduction in musculoskeletal imaging were also shown in recent clinical studies. Previous studies reported improved visualization of temporal bone compared to MDCT at lower radiation doses [13, 41, 42, 52]. A similar dose saving potential was also shown for the spine [19, 44], shoulder and pelvis [36], and the wrist [35]. Other clinical and cadaver studies showed improved visualization without dose penalty [16, 23, 53].

Electronic noise and signal-to-noise ratio

Another advantage of the PCD technology is the elimination of electronic noise due to the direct conversion of X-ray photons into an electrical signal [1, 2, 5]. Consequently, images show an improved signal-to-noise ratio (SNR) as well as an improved contrast-to-noise ratio (CNR), which has also been shown, e. g., for abdominal imaging [2, 5, 54, 55]. SNR is defined as the ratio between CT values in a predefined region (e. g., trabecular bone) and the image noise (standard deviation of CT values). In first experimental studies, we showed that image noise was significantly lower on PCD-CT compared to EID-CT at various $CTDI_{vol}$ values with a consequently significantly improved SNR (ratio between CT values in bone and standard deviation of CT values in air), which resulted in a relative improvement in SNR of up to 36 % [15].

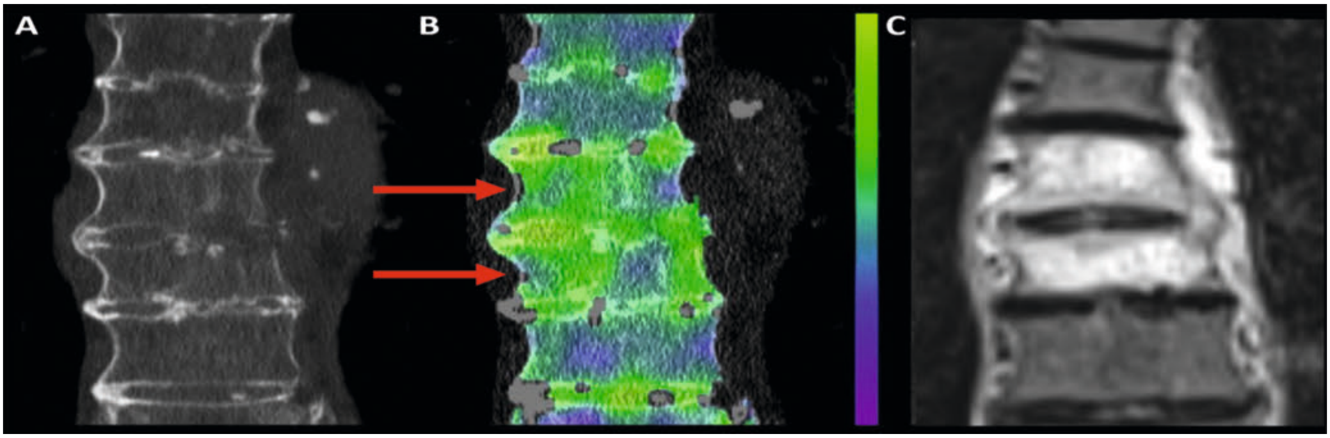
Other PCD-CT studies assessed the CNR, calculated as the ratio between the difference between CT values in bone and fat and image noise (standard deviation measured in bone or fat) [17, 23]. Previous studies showed that CNR is significantly higher in PCD-CT compared to EID-CT, resulting in an improved delineation and visualization of bone structures [11, 16, 17, 19, 23, 43, 56].

Spectral imaging

Due to the multi-energy acquisition capability of PCD, all images are acquired in spectral mode – without adding radiation dose. Therefore, spectral image postprocessing can be performed for each scan [9]. In bone imaging, material classification (for example, the detection of urate crystals or calcium pyrophosphate crystals) is an important issue in the clinical routine [9, 57]. Dual-source dual-energy CT is an established proven technique in order to visualize urate crystals in patients with suspected gout [58]. However, this often implies a trade-off between using spectral imaging or a high-resolution technique [9]. In clinical routine and in patients with suspected gout, a combination of high-resolution and multi-energy imaging would be desirable. Using PCD-CT, both UHR mode and spectral imaging can be combined. ▶ **Fig. 4** shows a case with evidence of a small amount of urate crystals in the metatarsophalangeal joint and points out the value of PCD-CT for imaging in suspected gout. Spectral imaging can also be used for imaging of joint spaces and delineation of small cartilage defects after intraarticular contrast injection [9, 59, 60]. A recently published study by Garcelon et al. showed the ability of spectral imaging to visualize cartilage and subchondral cysts on knee CT without using contrast agent in cases with osteoarthritis [61].

Spectral imaging is also important in the diagnosis of acute trauma and in the detection of fractures. In most cases of suspected fractures, radiography is performed with additional CT in unclear cases or in cases with a need for further visualization of fracture morphology. However, there are a few cases (especially in fractures not involving the bone cortex) in which CT cannot detect the fracture. Then, further MRI is necessary to detect edema-like signal intensity as an indirect sign of a fracture [62]. However, access to MRI may be limited in clinical routine and in the emergency setting due to its availability, the long duration of the examination, and potential contraindications (e. g., pacemaker, metal implants). Previous studies on dual-energy CT (DECT) delivered promising results in the detection of bone marrow edema using virtual non-calcium images (VNCa) [63, 64, 65, 66, 67, 68]. This virtual spectral postprocessing enables the detection of discrete changes in the bone marrow by suppressing the high attenuation of bone structures and thereby enhancing the visualization of water (edema) in the bone marrow. This postprocessing can be routinely performed in PCD-CT [69].

Preliminary data from our department showed promising results with detection of bone marrow edema in patients with fractures of the spine (▶ **Fig. 5**). In this case, we showed CT of the thoracic spine of a patient with acute back pain. Conventional CT images were not able to detect an acute fracture. After postprocessing of the images using spectral data, we were able to show bone marrow edema (shown in green) in thoracic vertebrae 6 and 7 but not in the other visualized vertebrae. The bone marrow edema was confirmed with the gold standard imaging method, MRI, within 24 hours after the CT scan. Postprocessing



▶ **Fig. 5** CT imaging of the thoracic spine in a patient with acute upper back pain. Conventional CT images show no acute fracture (**A**); image postprocessing (virtual noncalcium, VNCa) shows bone marrow edema in thoracic vertebrae 6 and 7 (**B**). Increases in attenuation (e. g., bone marrow edema) are shown in green, whereas fat is visualized in purple. Bone marrow edema was confirmed by MRI within 24 hours (**C**).

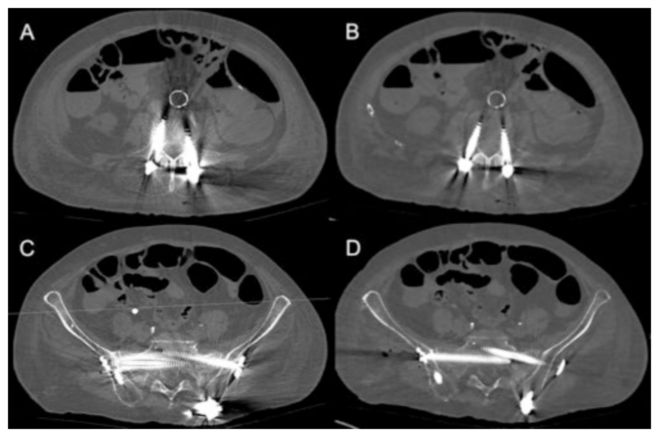
is based on virtual non-calcium (VNCa) imaging, a three-element decomposition technique that is known from DECT [69, 70]. In this technique, the typical attenuation of yellow and red bone marrow is defined as the baseline. It enables the generation of calcium images and VNCa images separately. Bone trabeculae are removed, which permits direct visualization of the bone marrow [69]. Also, for imaging of pelvic fractures, this new technique shows promising results in our first clinical experiences. Using VNCa, bone marrow edema was also detected in the pelvis in two examples.

These findings open up new possibilities and might obviate MRI in the near future in selected cases. Further prospective studies are necessary to evaluate the diagnostic accuracy of spectral imaging for the detection of bone marrow edema in different regions of the body and to compare it to MRI as the gold standard imaging method.

Metal artifact reduction

Trauma surgery often requires the use of metal implants in the spine or the extremities. In the postoperative setting and also during follow-up, further CT imaging is often necessary. However, due to the formation of metal artifacts, interpretation of adjacent structures is often not possible. Many patients also have dental implants which often have strong beam hardening artifacts. This renders the visualization of neighboring structures nearly impossible. Modern CT scanners employ algorithms for the reduction of beam hardening artifacts using iterative metal artifact reduction techniques [9, 71].

However, spectral imaging was also shown to have great potential for metal artifact reduction. With the multi-energy acquisition of PCD-CT with each scan, spectral postprocessing can be routinely performed. Spectral postprocessing enables the generation of virtual monoenergetic images (VMI) [1, 2, 5, 9]. Many previous studies assessed techniques of metal artifact reduction. DECT showed promising results with a reduction of beam hardening effects at higher keV levels [9, 72]. The most convincing results were shown for the combination of iterative metal artifact reduction (IMAR) and higher keV levels on DECT [73, 74, 75, 76, 77].

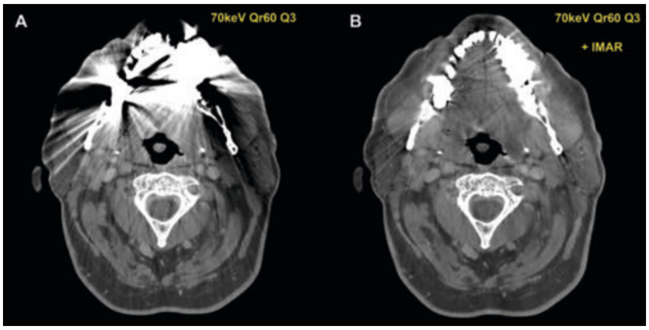


▶ **Fig. 6** Patient with screws in the lumbar spine and the pelvis. The left column (**A, C**) shows conventional 70 keV reconstructions. 110 keV reconstructions show a significant reduction of metal artifacts both in the spine and in the pelvis (**B, D**).

The first phantom-based studies on a PCD-CT scanner assessed the value of IMAR [78], tin filtration [79], VMI [80], projection-based material decomposition [81, 82, 83], as well as the combination of IMAR and VMI [84, 85].

The first clinical studies on PCD-CT also showed promising results for metal artifact reduction, for IMAR, as well as for VMI and/or the combination of both methods.

A recently published study by Popp et al. showed that VMI enables metal artifact reduction after spine surgery and determined 110 keV as the optimal energy level for artifact reduction [86]. As spectral imaging is assessed routinely on a PCD-CT scanner, automatic 110 keV reconstruction can be easily performed and can help radiologists and clinicians evaluate CT images after spine surgery (▶ **Fig. 6**). Similar results were also shown for artifact reduction after total hip replacement [87].



▶ **Fig. 7** Contrast-enhanced CT of the neck in a patient with dental implants. **A** shows conventional 70 keV reconstructions with a Qr60 Q 3 kernel. Using IMAR, there was a significant reduction of metal artifacts with consequently better delineation of surrounding structures (**B**).

For the reduction of dental metal artifacts, IMAR showed promising results. This effect could further be enhanced with high keV VMIs on a PCD-CT scanner, as recently published by Risch et al. [88] (▶ **Fig. 7**). The reduction of dental metal artifacts is very important in clinical routine. It is very common, and it often limits the assessment of cervical structures or structures in the brain. Other clinical studies also suggested the combination of IMAR and VMI for metal artifact reduction in the hip [89] and for dental implants [90].

Critical assessment

In the following paragraph, we aim to perform a critical assessment of the new technology. Despite the many advantages that were presented above, there might also be some limitations in clinical routine and musculoskeletal imaging at this time. Due to the rapid technical development, there are many different reconstruction algorithms and reconstruction kernels available. These differences between the centers might lead to confusion. Therefore, standardization of protocols for musculoskeletal imaging and specific issues is mandatory.

Due to the possibility of reconstructing spectral data within each scan, huge data sets are generated. This requires not only significant computational power, but also requires radiologists to examine the rapidly growing number of images and to write the reports. To avoid a loss of information, more technical and also human resources might be necessary. This might be challenging, especially in times of shrinking resources.

Due to the novelty of the PCD technology, large studies and especially multi-center trials are currently not available. Regarding various clinical scenarios, data about the sensitivity and specificity of the new reconstruction algorithms or spectral data sets is lacking. Therefore, many applications (e. g., detection of bone marrow edema) are undergoing clinical testing at the moment and the diagnostic accuracy must be demonstrated in clinical trials.

Summary

This review summarizes recent clinical and experimental studies as well as our personal experiences with a new PCD-CT scanner regarding advances in musculoskeletal imaging.

In summary, this new groundbreaking technology has many advantages compared to conventional CT: reduction of image noise and elimination of electronic noise, improved spatial resolution combined with reduction of radiation dose, spectral imaging with the potential to detect bone marrow edema and gout, as well as metal artifact reduction.

Based on previous studies, PCD-CT is a very promising technology in musculoskeletal imaging that will be introduced in a wider range of clinical applications and might have the potential to improve imaging combined with a reduction of radiation dose.

However, further studies are necessary to assess the manifold possibilities of PCD-CT in musculoskeletal imaging, to examine new reconstruction and postprocessing methods, and to improve diagnostic accuracy.

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Conflict of Interest

The Department of Radiology received research funding from Siemens Healthineers for research in the field of photon-counting CT.

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