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## Title Page

*Type:* Interesting Image

*Title:* Hardware Failure: a Potential Pitfall in Assessing Recurrent Ewing's Sarcoma on Bone Scintigraphy

*Shortened title:* Hardware failure or Recurrent Sarcoma

*Authors:* D. Vriens, MD\*; A.I.J. Arens, MD\*; J.W.J. de Rooy, MD†; H.W.B. Schreuder, MD, PhD‡; P.P.T. Brons, MD, PhD§; M. Gotthardt, MD, PhD\*  
Depts. of \*Nuclear Medicine, †Radiology, ‡Orthopedic Surgery and §Pediatric Hemato-Oncology

*Affiliation:* Radboud University Nijmegen Medical Centre.  
P.O. Box 9101, 6500 HB Nijmegen, the Netherlands

*Correspondence:* D. Vriens, MD

Department of Nuclear Medicine (internal postal code 444)

Radboud University Nijmegen Medical Centre

P.O. Box 9101, 6500 HB Nijmegen, the Netherlands

Phone: +31-24-3614048, Fax: +31-24-3618942

E-mail: [D.Vriens@nucmed.umcn.nl](mailto:D.Vriens@nucmed.umcn.nl)

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## Abstract:

A fourteen-year-old male was treated for non-metastasized femoral Ewing's Sarcoma with inductive and consolidation chemotherapy together with surgical resection of the diaphysis with interposition of an allograft. During follow-up, a remarkable increase in osteoblastic activity in the distal osteotomy plane was seen on  $^{99m}\text{Tc}$ -HDP scintigraphy 29 months after surgery that was highly suspicious of recurrence. Revision of radiographs showed delayed consolidation, induced by failure of hardware as the cause of increased tracer uptake. This was confirmed 6 months later by scintigraphy. **Conclusion:** Bone scintigrams should be interpreted with available conventional X-rays to avoid false-positive results.

*Keywords:* Sarcoma, Ewing's; Radionuclide Imaging; Bony Callus; Pitfall

## Legends:

**Figure 1:** Anterior planar bone scintigrams made 4h after injection of  $\sim 500\text{Mbq}$   $^{99m}\text{Tc}$ -disodium hydroxymethylene diphosphonate (HDP) during follow-up of a patient with Ewing's sarcoma (ES). Images are resized to the same patient height.

A 14-year old boy initially presented with leg pain without trauma. Pre-treatment bone scintigraphy showed increased tracer concentration in the right femoral diaphysis on both early (not displayed) and late (A) series. In accordance with magnetic resonance imaging (MRI), which is suggested to be superior for local staging of ES due to its superior accuracy in assessing intramedullary and soft tissue extension<sup>1, 2</sup>, this was most likely due to osteomyelitis. However, malignancy could not be excluded (differential diagnosis: ES and hematological malignancies). Histopathological examination proved ES. There was no evidence of metastases on chest CT<sup>3</sup> and whole-body  $^{18}\text{F}$ -FDG PET/CT<sup>4-8</sup>.

He was treated according to the EURO-E.W.I.N.G. protocol with a four-drug induction regimen, consisting of 6 cycles of vincristine, ifosfamide, doxorubicin and etoposide (VIDE) and a three-drug post-operative

regimen consisting of 8 cycles of vincristine, actinomycin D and ifosfamide (VAI).<sup>9, 10</sup> In total 17cm of the femoral diaphysis was resected followed by reconstruction by an allograft femur shaft, a retrogradely placed intramedullary locked nail and a fixed angle femoral plate with screws. The resected diaphysis was without any sign of viable tumor cells. Since most relapses occur in the first three years (but can arise up to 19 years after surgical resection<sup>11</sup>) careful follow-up for both recurrence and long-term sequelae of therapy, at least 4-6 times per year in the first three years, twice a year up to 5 years after treatment and at least once a year thereafter is warranted.<sup>10</sup> This should include imaging for local recurrence by conventional X-ray, <sup>99m</sup>Tc diphosphonate bone scintigraphy and chest X-ray for pulmonary metastases.

Follow-up (B-D) by <sup>99m</sup>Tc-HDP bone scintigraphy showed decreasing osteoblastic activity at the proximal osteotomy plane corresponding to progressive fracture healing, but a stable and increased bone turnover up to 2 years postoperative (p.o.) in the distal anastomosis. Two and a half years p.o. (E), there was a sudden increase in osteoblastic activity which was highly suspicious of recurrent ES.

**Figure 2:** Anteroposterior conventional X-rays during postoperative surveillance of this patient scaled to the same femoral length. Progressive consolidation of the proximal osteotomy plane can be seen while healing of the distal anastomosis is delayed up to two years post-surgery (A-E) corresponding to the <sup>99m</sup>Tc-HDP scintigrams. First, the distal anti-rotation screw breaks (C) followed by failure of the femoral plate (F, figure 3), possibly due to extra stress on this piece of hardware. Fracture of hardware occurs in approximately 13% of the cases.<sup>12</sup> As a consequence, progressive consolidation and callus formation of the distal junction (F) is initiated, visible 29 months post-operatively. Union rate in these kind of allograft reconstructions is around 25%.<sup>12</sup> Interpretation of the bonescans without knowledge of time-dependent anatomical changes therefore may lead to the incorrect conclusion of recurrent ES instead of delayed union.

**Figure 3:** Lateral (left) and anteroposterior (right) detail of the distal osteotomy plane 29 months postoperative. The fracture of the femoral plate (arrows) causing the delayed consolidation can be seen.

**Figure 4:** Bone scintigram 4 hours after injection of ~500MBq of <sup>99m</sup>Tc-HDP (left) and plain anteroposterior conventional X-ray (right) 6 months later (35 months postoperative). The radiograph shows progressive healing of the distal osteotomy plane. Correspondingly the bone scan shows decreasing osteoblastic activity in comparison to the previous scan, confirming the diagnosis.

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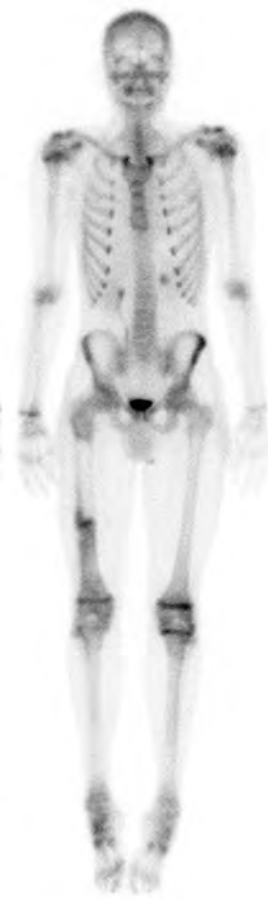
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**A** – pre-operative



**B** – 11mo p.o.



**C** – 17mo p.o.



**D** – 23mo p.o.



**E** – 29mo p.o.



**A** – 1mo p.o.   **B** – 11mo p.o.   **C** – 13mo p.o.   **D** – 17mo p.o.   **E** – 23mo p.o.   **F** – 29mo p.o.





