

CONGRESSO NAZIONALE SOCIETÀ ITALIANA FISSAZIONE ESTERNA

Fissazione esterna nel trattamento
delle emergenze e traumi militari,
tecniche di ricostruzione degli arti e
trattamento degli esiti posttraumatici

ROMA

2025

16-17 MAGGIO 2025



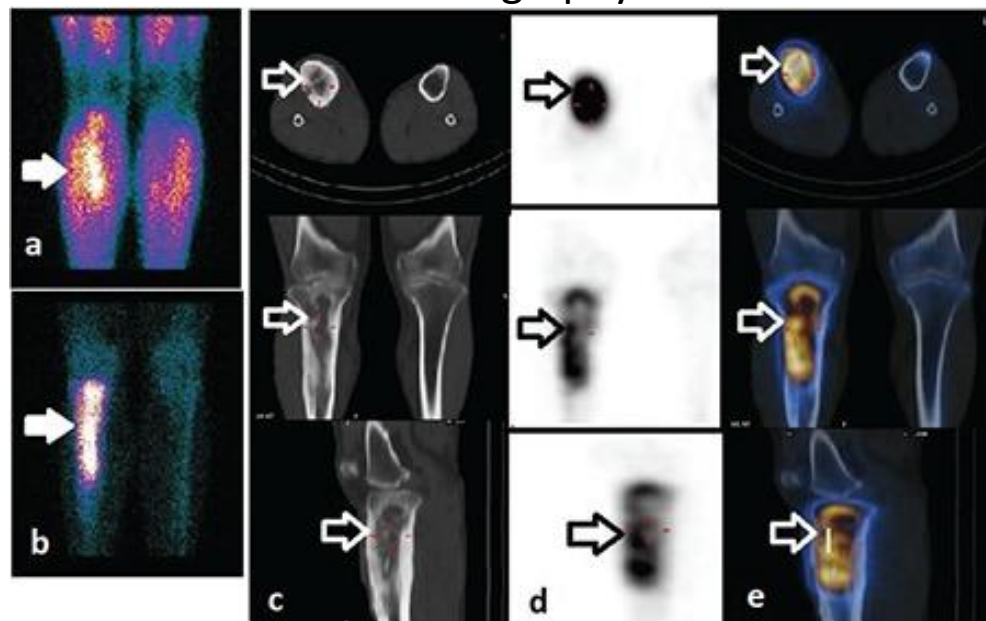
Recent progress in bone infection diagnostic imaging

Dr. Lidija Antunovic
Department of Nuclear Medicine
San Raffaele Hospital, Milan

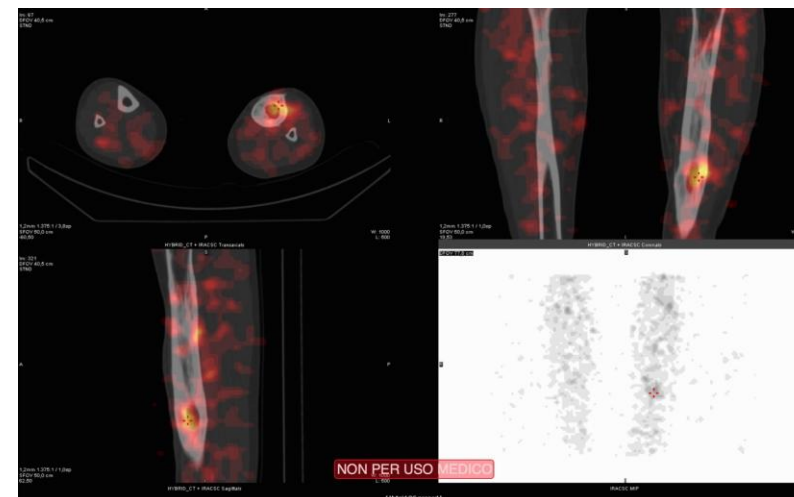


Bone scintigraphy

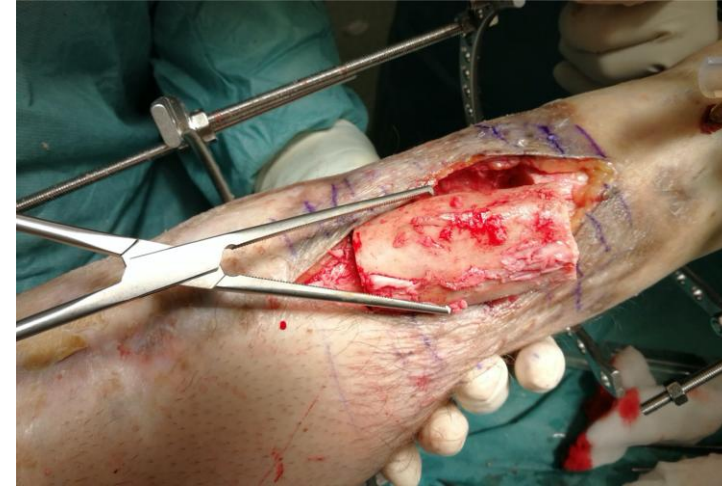
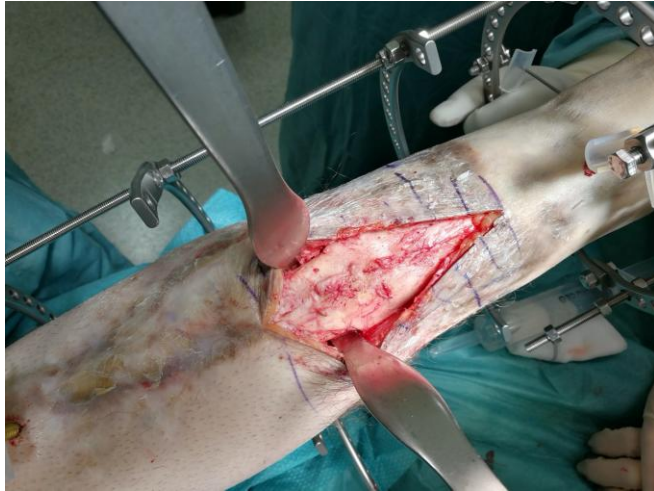
Courtesy of Nuclear medicine Padua University



SPECT/CT



Radiolabeled WBC scintigraphy



Radiolabeled WBC scintigraphy



^{18}F -FDG PET/CT

- evaluation of areas of increased glucose metabolism
- larger availability, major patient comfort
- both functional and morphological information
- accuracy similar to WBC scintigraphy
- in presence of metal devices, non-attenuated images to avoid presence of artefacts
- higher accuracy for particular localizations (ei. vertebra)



^{18}F -FDG PET/CT

Courtesy of Dr. A. Kirienko

40 y.o. male

Priest from Africa (Tanzania)

No comorbidity

2014

Motocycle incident, fracture of both bone of the left leg, no other lesions

Treated in emergency with external fixation and after with a plate and screws

April 2015

Local persistent infection with fistula; plate and screw removal and antibiotic therapy

November 2015

More serious pain, fever, swelling, redness

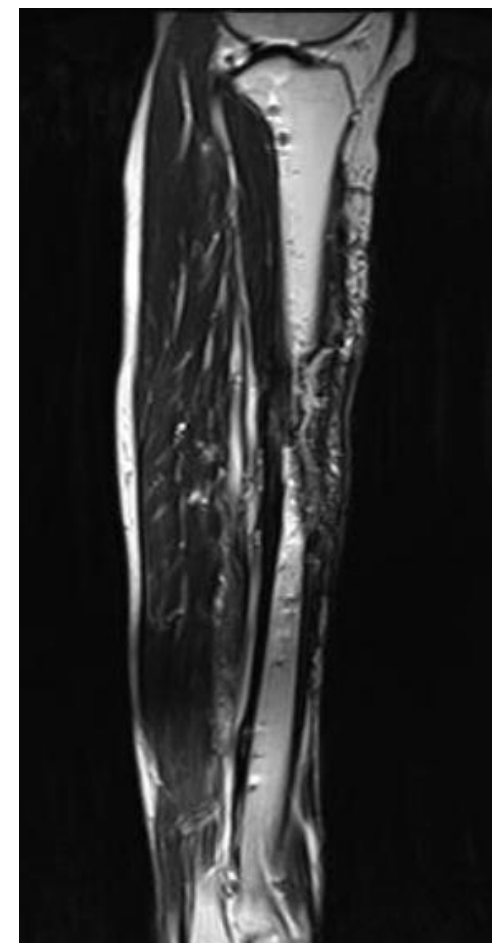
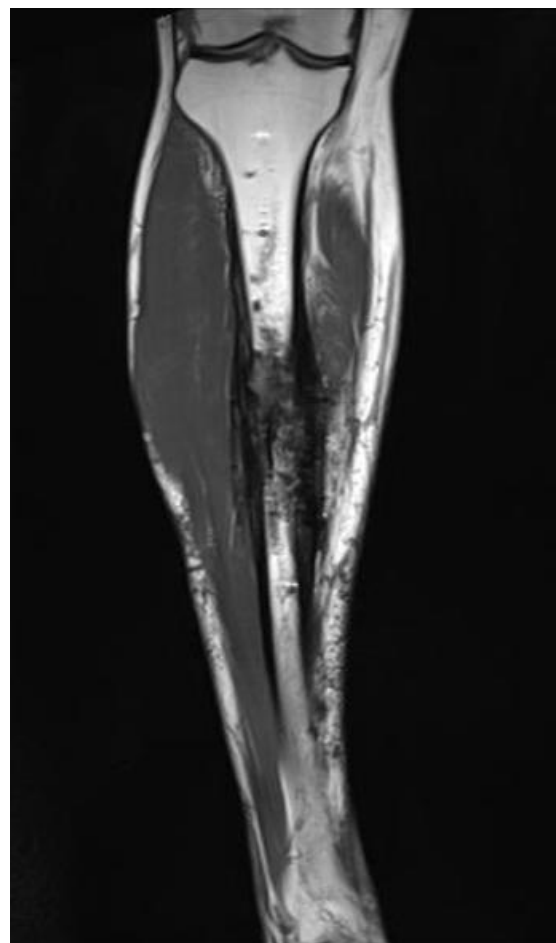
January 2016 in Italy

MRI: cronic osteomyelitis of the left tibia

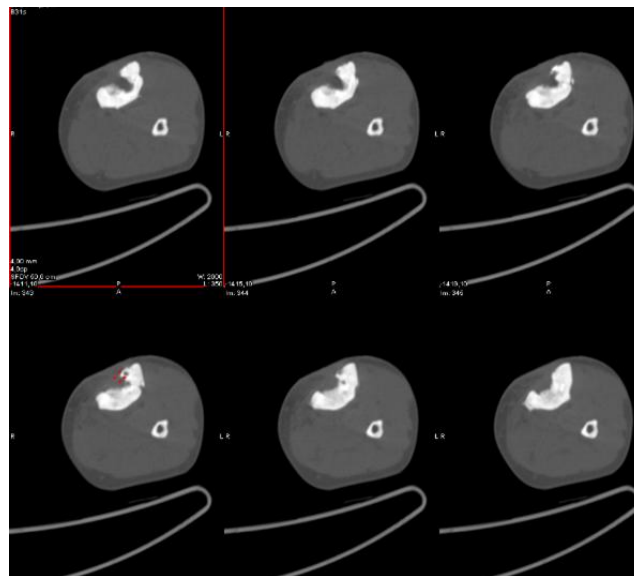
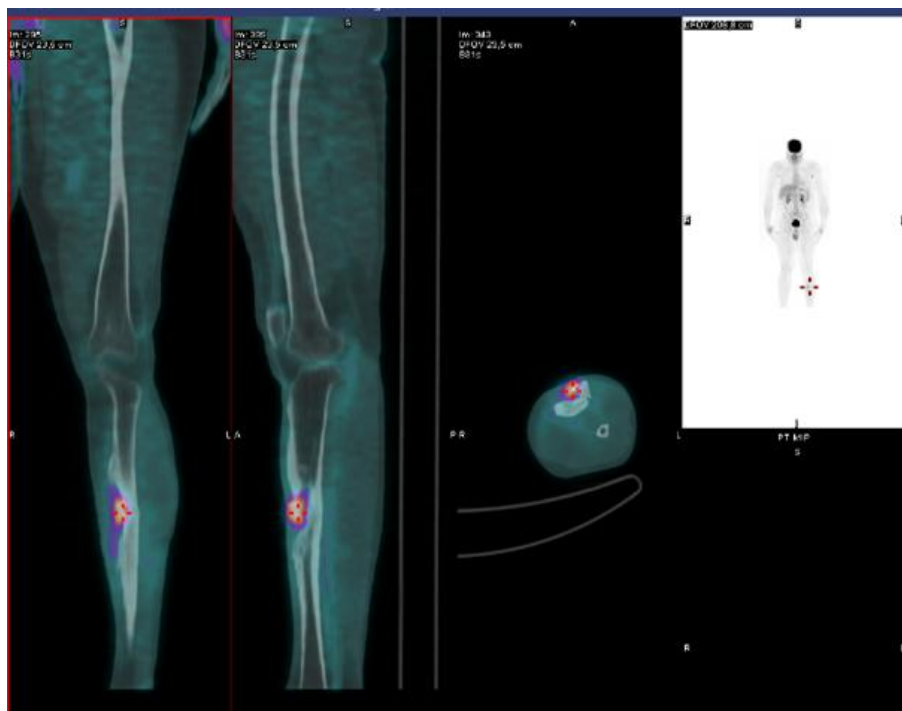
February 2016

Surgery: osteotomy, debridement, stabilization with axial external fixator

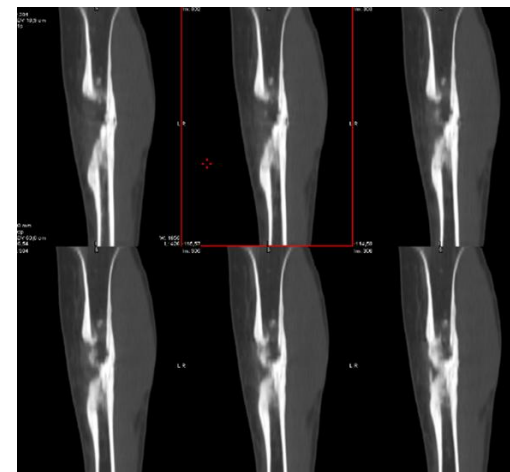
^{18}F -FDG PET/CT



^{18}F -FDG PET/CT



Area of intense focal uptake in the proximal part of the left tibia diaphysis. On CT images cortical interruption, sclerotic reaction, sequestrum.



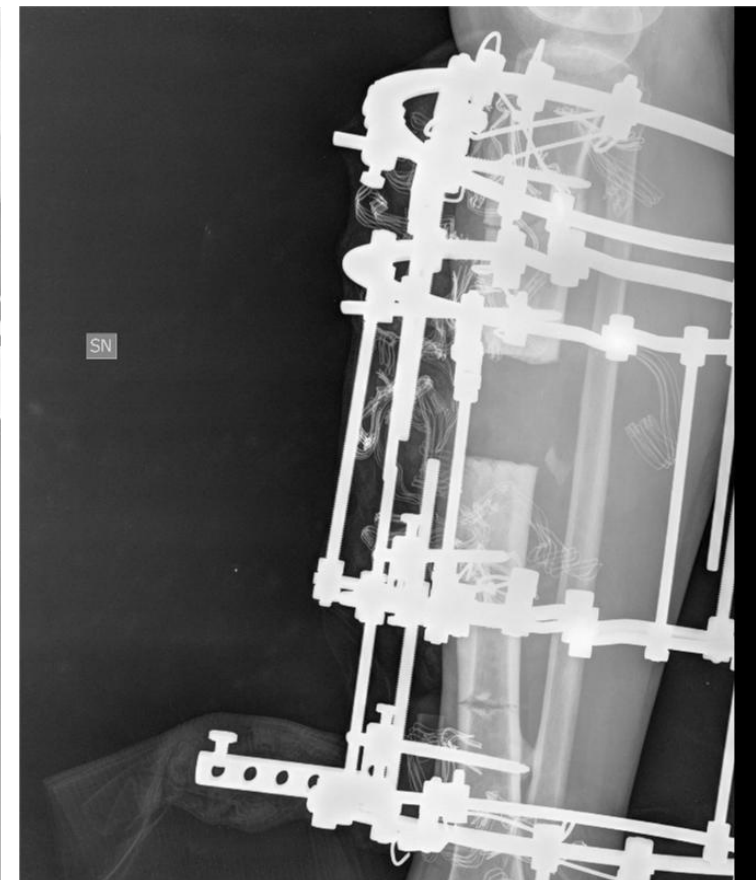
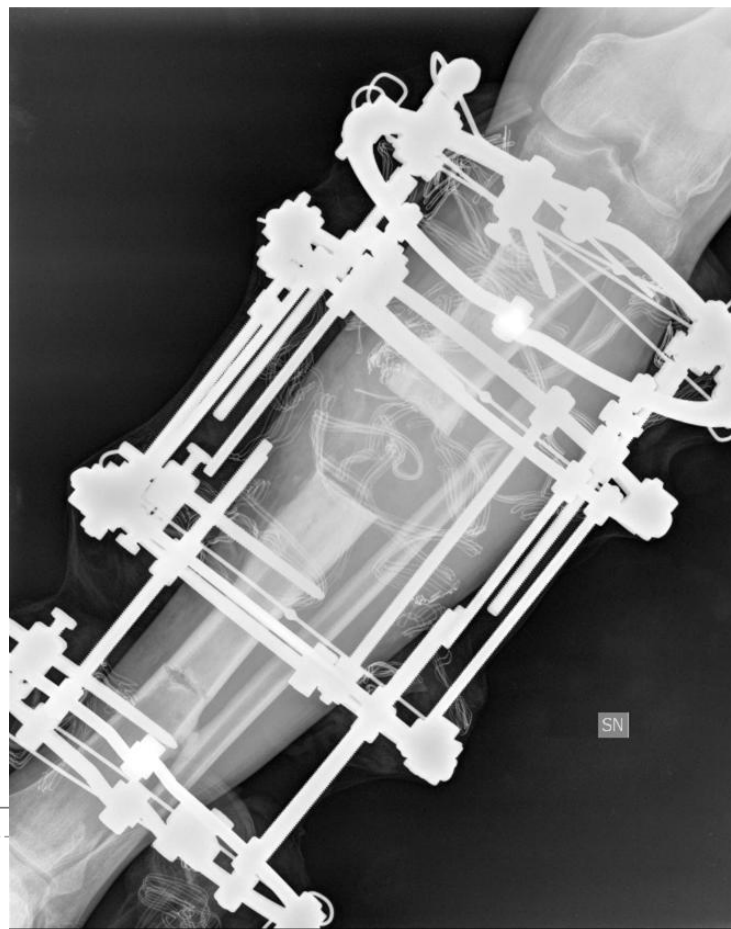
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**MICROBIOLOGIA**

ESAME COLT. FRAMMENTO OSSEO

Esito

Positivo

- 1 - *Staphylococcus aureus*
- 2 - *Pseudomonas aeruginosa*
- 3 - *Enterococcus faecalis*

Nota isolato

Daptomicina MIC= 2 mg/L Per gli isolati classificati come resistenti alla gentamicina di alto livello (HLGR), non è possibile ottenere sinergismo di tutti gli aminoglicosidi (eccetto streptomicina e arbekacina) con beta-lattamici o glicopeptidi.

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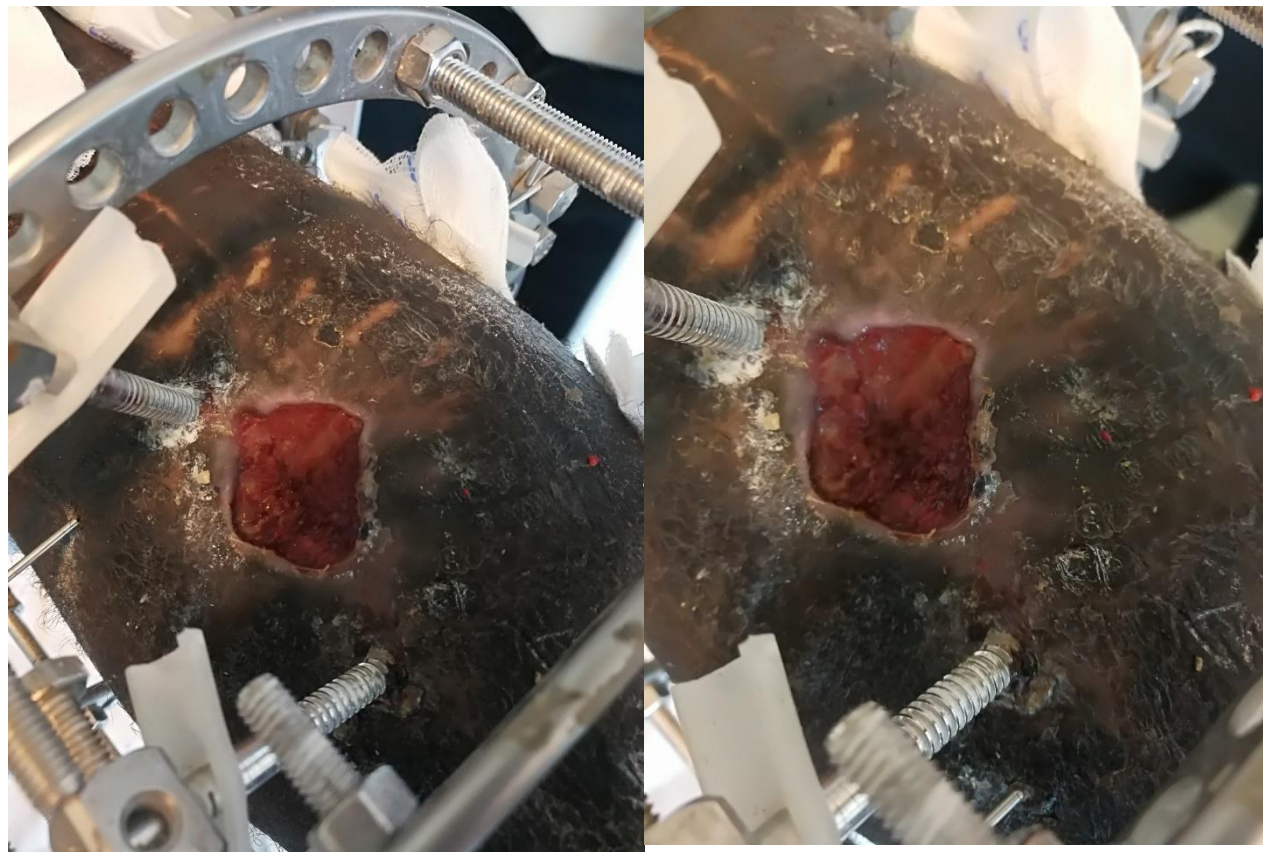


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7 months







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23.04.2018

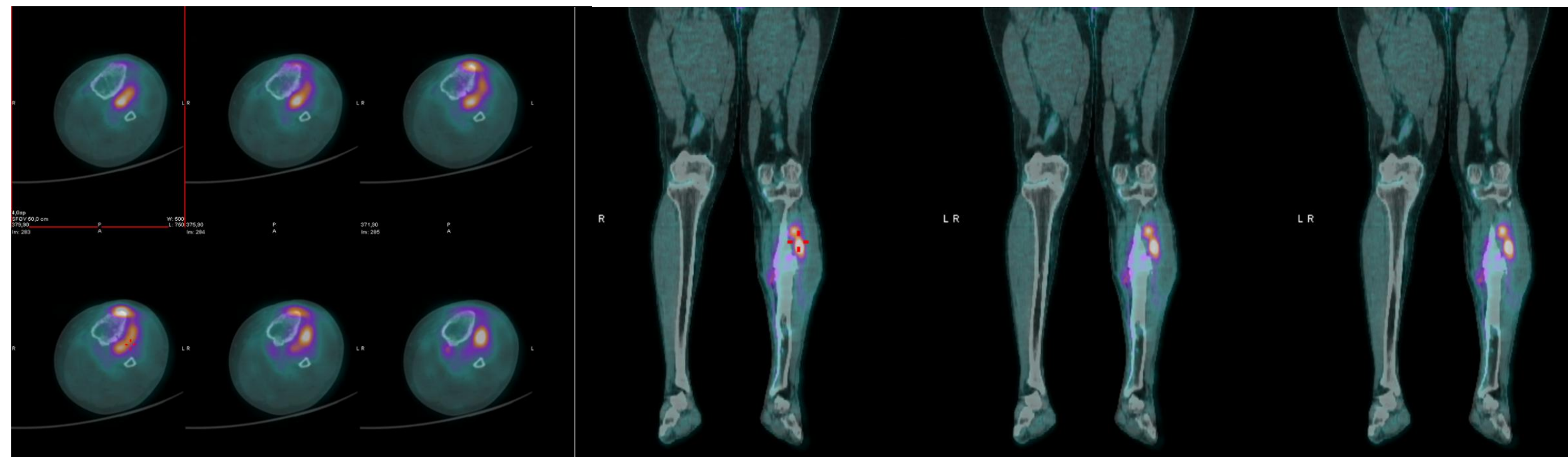


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30.08.2018

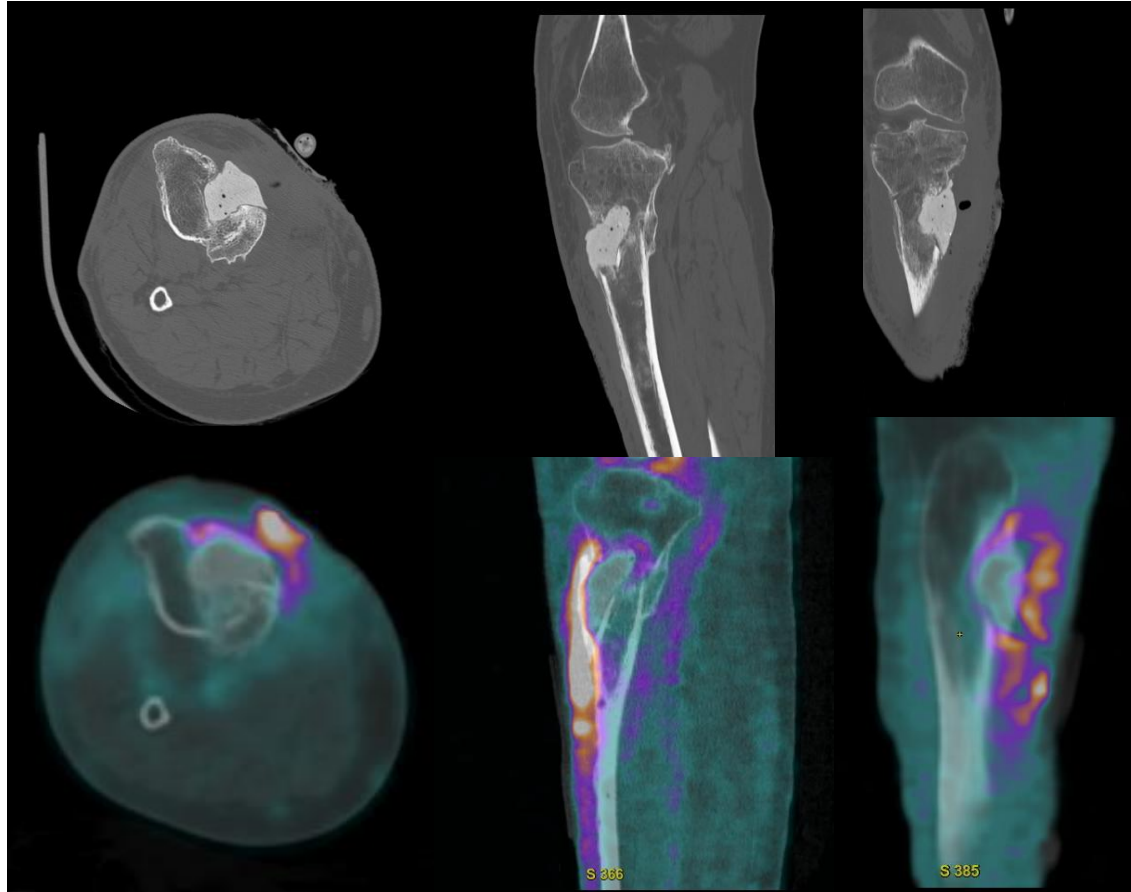


24.07.2019



16.05.2019.





Car incidence 08/2023, after 14 months plate and screws were removed, after a short period of time development of fistula, surgical debredment;
Now again the fistula is open.

^{18}F -FDG PET/CT

Visual analysis

PET



i) Asymmetrical [^{18}F]FDG uptake in the non-union region, compared to the contralateral area



ii) Distinguished areas of focal [^{18}F]FDG uptake involving bone fragments of the non-union

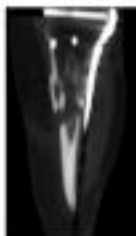


iii) Increased diffuse uptake along the bone-metallic devices or bone-bone or bone-graft surfaces.

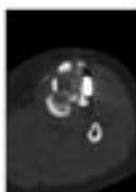
CT



a) Sclerotic and rounded bone profiles with an important interfragmentary gap (calus fracture sign)

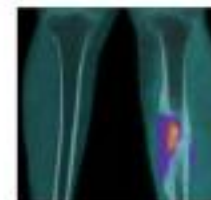


b) Absence of trabecular bone structure, increased intramedullary density, with eventual presence of Brodie abscess or sequestrations



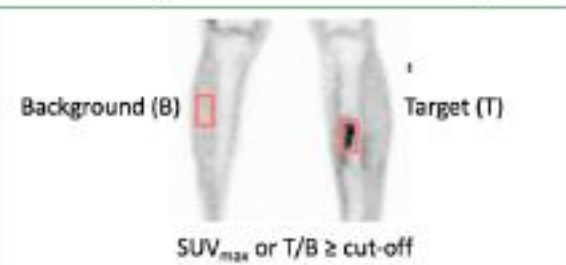
c) Increase of the soft tissue density, tumefaction, periosteal effusions, eventual presence of fistula

PET/CT



At least one PET (i-iii) and one CT (a-c) criteria for positivity or consensus in discordant cases

Semi-quantitative analysis



Visual plus semi-quantitative analysis

Presence of at least one PET and one CT criteria or consensus in discordant cases

and

$\text{SUV}_{\text{max}} \geq$ or $\text{T/B} \geq$ cut-off



^{18}F -FDG PET/CT

Metric	visPET	visCT	visPET/ CT	$\text{SUV}_{\max} \geq 5.92$	T/ B ≥ 2.74	visPET/ CT + $\text{SUV}_{\max} \geq 5.92$	visPET/ CT + T/B ratio ≥ 2.74
Sensitivity	92%	88%	92%	60%	88%	41%	80%
Specificity	64%	55%	68%	86%	55%	80%	77%
PPV	74%	69%	77%	83%	69%	81%	80%
NPV	88%	80%	88%	66%	80%	39%	77%
Accuracy	79%	72%	81%	72%	72%	55%	79%
LR+	2.53	1.94	2.89	4.40	1.94	2.03	3.52
LR-	0.13	0.22	0.12	0.46	0.22	0.74	0.26
Post-test probability	74%	69%	77%	83%	69%	81%	80%
Post-test odds	2.88	2.20	3.29	5.00	2.25	4.33	4.00

Comparison of different diagnostic modalities

Imaging modality	Advantages	Disadvantages	Comments
CT	Good indicator of bone changes and fracture consolidation	Lower soft tissue contrast, lack of bone marrow oedema, disturbed by metallic implants, radiation burden	Intermediate sensitivity and specificity; new CT techniques for metallic artefact reduction
MRI	Excellent soft-tissue contrast, bone marrow oedema, no radiation burden, fast technique completed in one session	Hampered in postoperative/posttraumatic conditions up to 1 year and by metallic implants, expensive, not widely available	High sensitivity and intermediate specificity; new MRI sequences for metallic artefact reduction
WBC/AGA SPECT-CT	Good localisation between bone and soft tissue infections, also in the immediate postoperative period, altering the surgical approach, high interobserver agreement	Serial time-point imaging necessary, needs specialized equipment and trained personnel (WBC), no standardized protocol, radiation burden, expensive	Intermediate to high specificity and sensitivity
FDG PET-CT	Excellent localisation between bone and soft tissue infections, altering the surgical approach, fast technique completed in one session, high interobserver agreement	No universal accepted interpretation criteria, false-positive test results in recent fractures, expensive, not widely available, radiation burden	Intermediate to high sensitivity and specificity; highest anatomic resolution among functional techniques

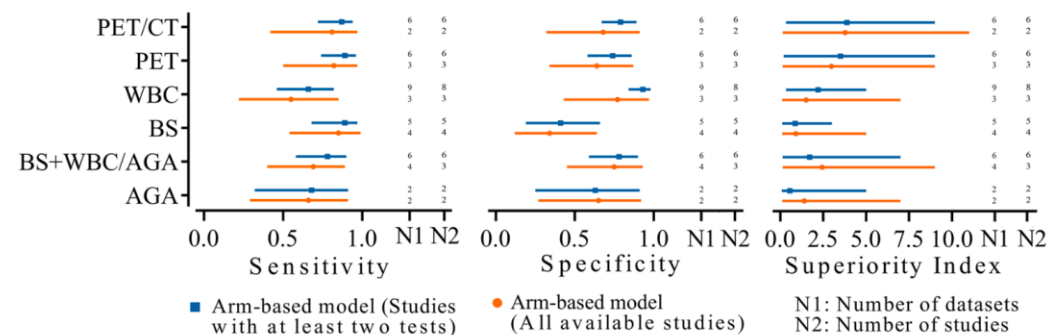
Review article

Hybrid imaging of complicating osteomyelitis in the peripheral skeleton

Filip Gemmel^{a,b}, Bliede Van den Broeck^b, Silvie Vanelstraete^c,
Benoit Van Innis^d and Wouter Huysse^e

Nuclear
Medicine
Communications

Archives of Orthopaedic and Trauma Surgery (2021) 141:1115–1130

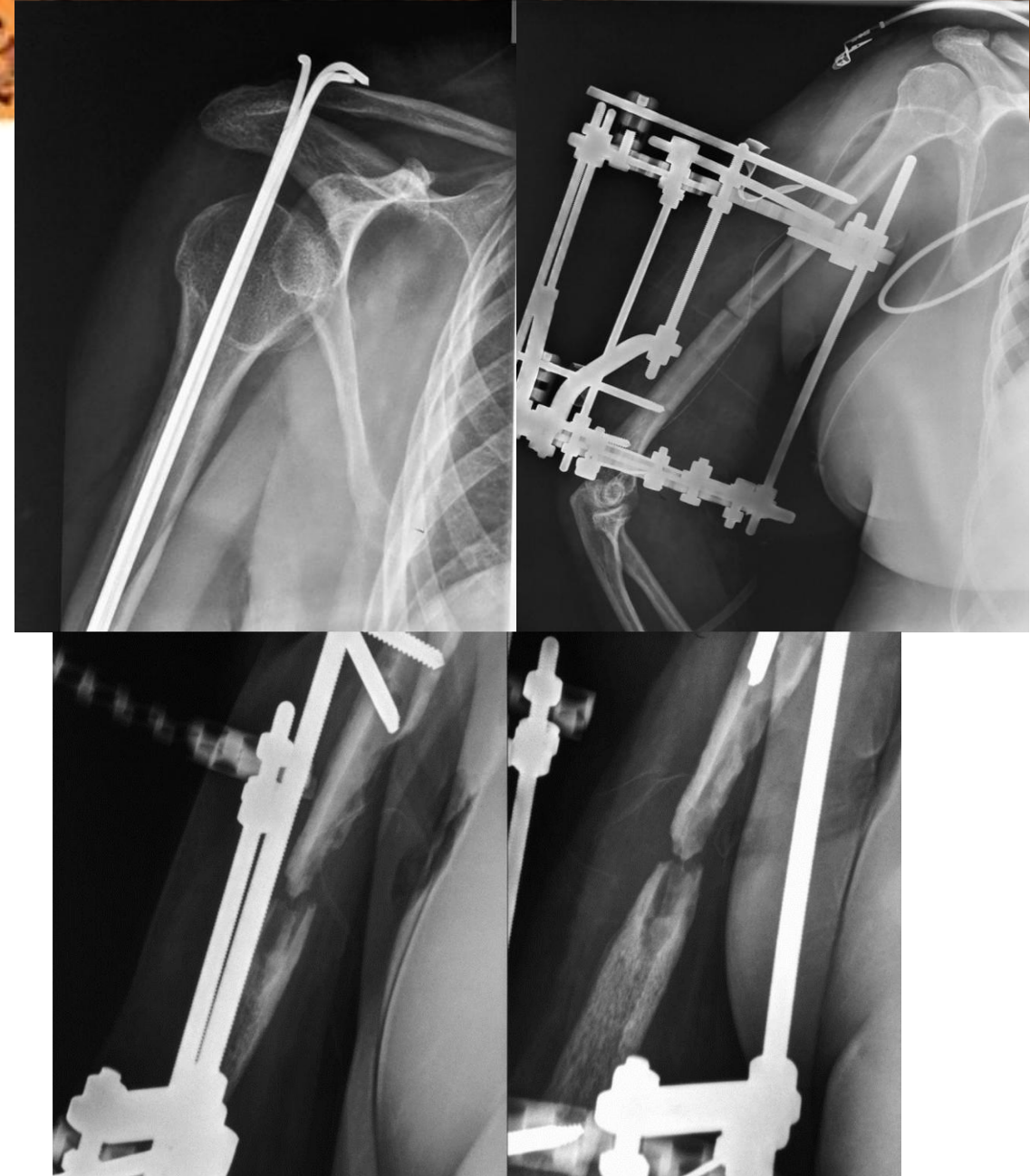


^{18}F -Fluoride PET/CT

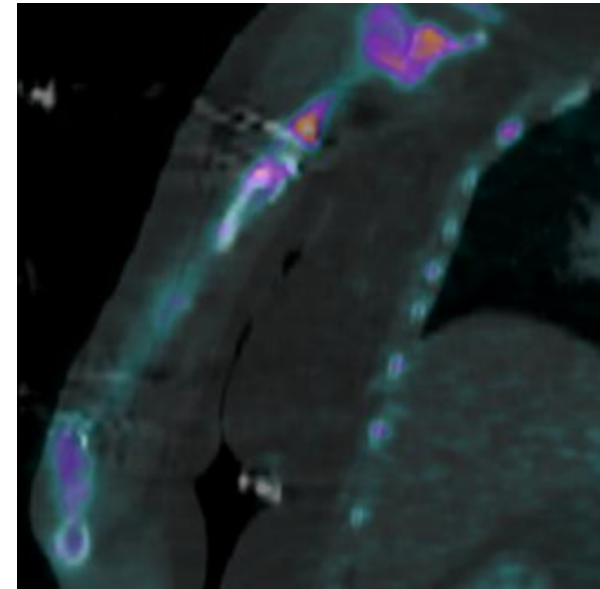
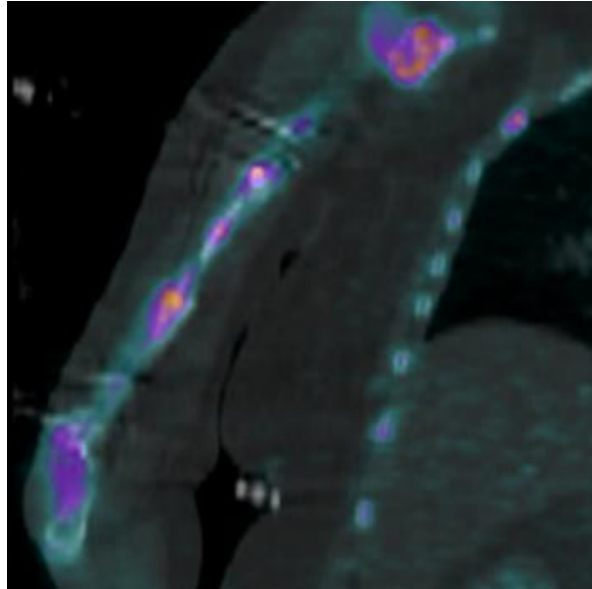
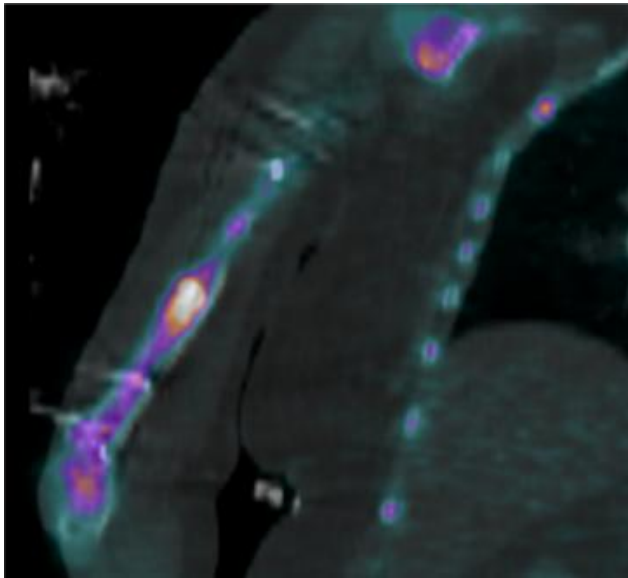
- Bone vitality
- Indication for surgical bone resection

Clinical Case-Fluoride

53 y.o. female with the transverse midshaft humerus fracture;
attempt for reaming and nailing, but in vain, because of the narrow endomedullary canal. 2 mm K wire osteosynthesis with «sufficient stability»;
Complicated with infection, removed K wires, debridment and External fixation.



^{18}F -Fluoride PET/CT



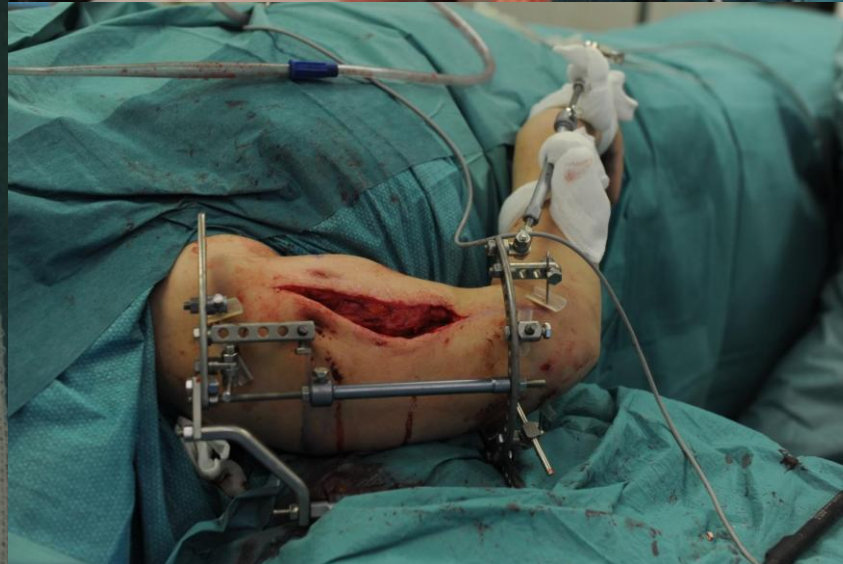
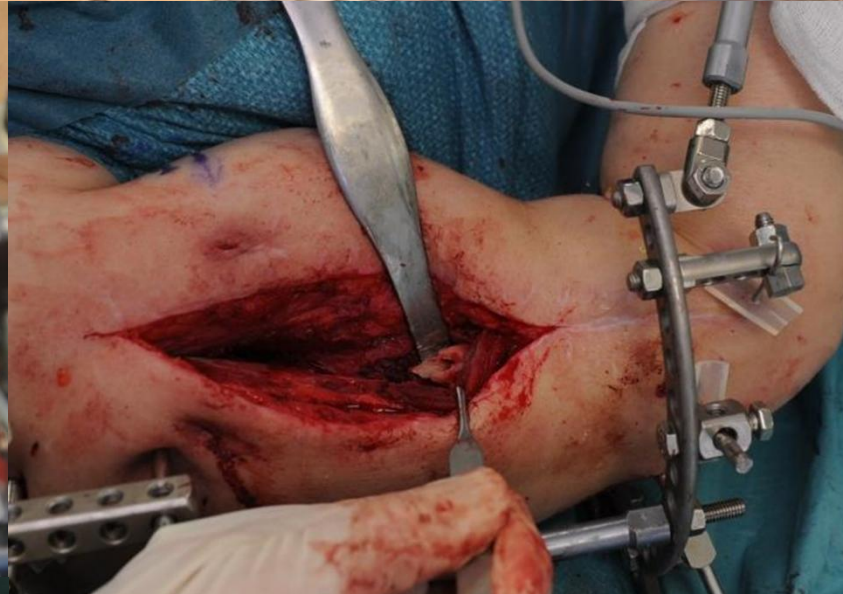
Alternation of areas of normal or increased tracer uptake (normal vital bone tissue) and areas of reduced uptake corresponding to bone tissue necrosis.

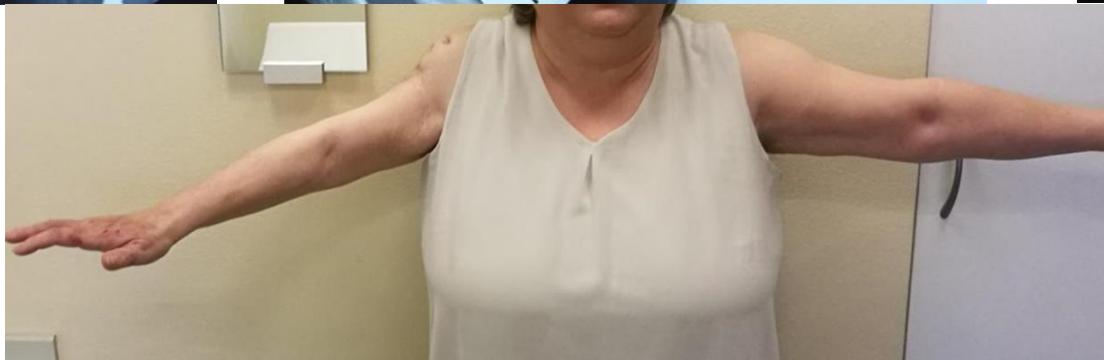
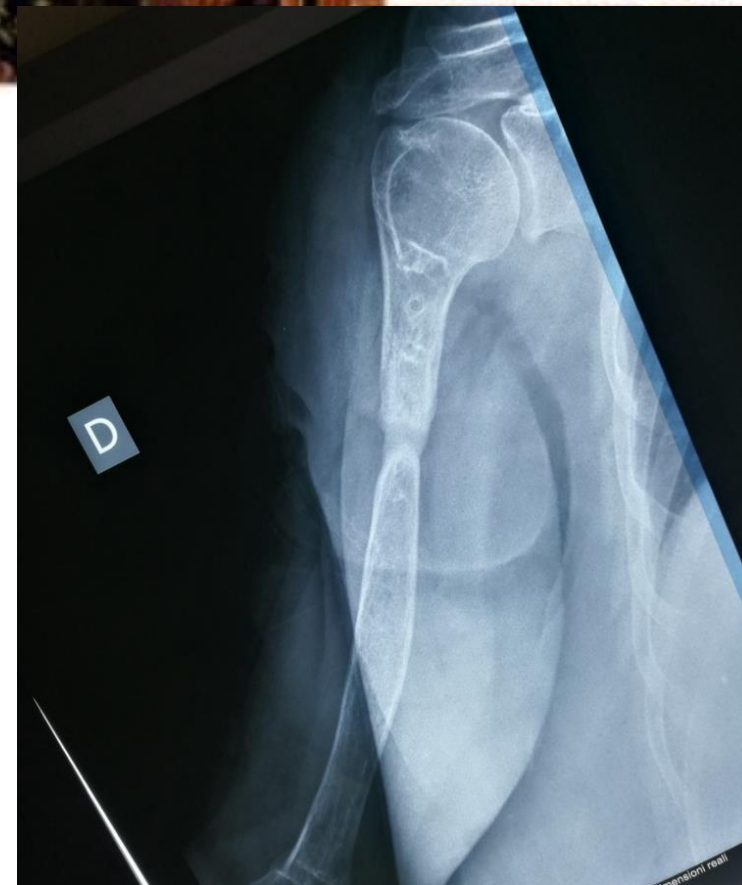
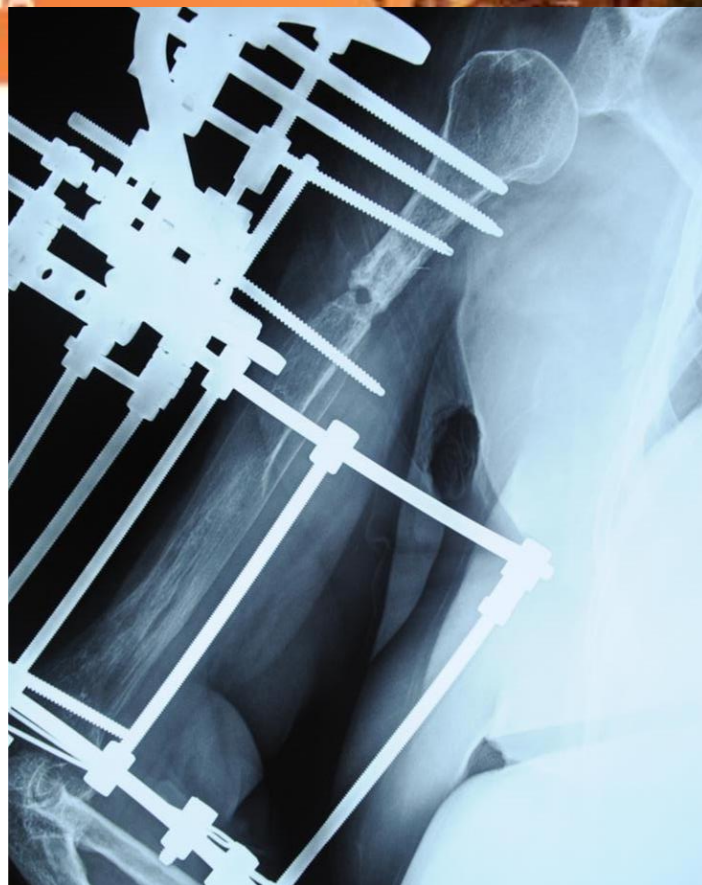
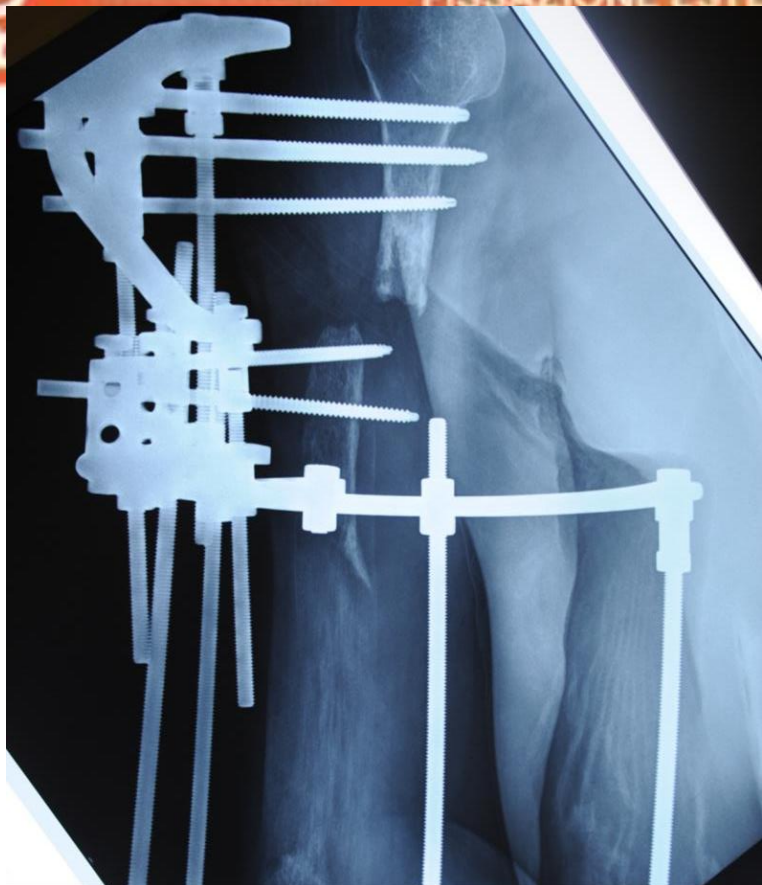
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Conclusions:

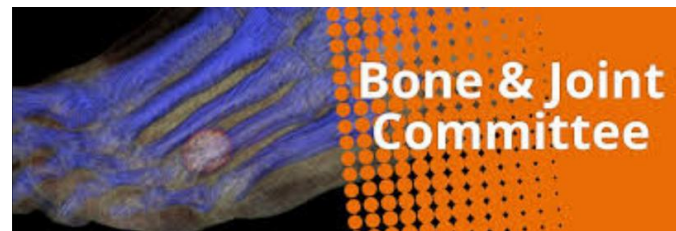
- Hybrid imaging offers anatomical and functional information;
- Variety of tracers exploring different pathophysiological processes;
- Need for high expertise in image interpretation;
- Impact on surgical decisions.

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Thank you!

