SPECT and SPECT-CT & infection and inflammation

John Buscombe
SPECT in infection

- Is there a role for SPECT?
- Is the extra time/cost justified
- Are there particular situations in which SPECT helpful
- Can be used in non-specific agents looking at the effect of infection on various organs
- Also used in more specific infection imaging eg Ga-67, WBCs etc
Parvovirus encephalitis treated with anti-virals

Pre-treatment

post treatment
Dupont et al Transplantation 2007

**TABLE 2.** Comparison of 99m Tc-DMSA SPECT findings in renal allograft recipients with and without a history of recurrent urinary tract infection.

<table>
<thead>
<tr>
<th></th>
<th>Recurrent UTIs (%)</th>
<th>Controls (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reflux</td>
<td>No reflux</td>
</tr>
<tr>
<td>N</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>No scars</td>
<td>2 (13)</td>
<td>6 (33)</td>
</tr>
<tr>
<td>One focal defect</td>
<td>5 (33)</td>
<td>3 (18)</td>
</tr>
<tr>
<td>Two focal defects</td>
<td>2 (13)</td>
<td>3 (18)</td>
</tr>
<tr>
<td>&gt;Two focal defects</td>
<td>6 (40)</td>
<td>5 (29)</td>
</tr>
<tr>
<td>Any focal defect</td>
<td>13 (87)</td>
<td>11 (65)</td>
</tr>
<tr>
<td>Segmental defect</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>
Dupont et al
DMSA SPECT in Tx

A=scar, B=rejection, C=vascular damage
Ga-67 in E.coli spinal OM
SPECT/CT for suspected bone infection on GS. A 56-y-old woman presented with fever, low back pain, and infected scar 1 mo after spinal surgery and was referred for GS for suspected vertebral osteomyelitis. (A) Planar posterior whole-body GS image (left) shows prominent abnormal uptake in left lower back, corresponding in part to regions of increased irregular uptake seen on planar posterior whole-body $^{99m}$Tc-MDP image (right) along operated vertebrae. (B) Transaxial GS SPECT/CT image (left) localizes abnormal uptake on GS (center) to paravertebral soft-tissue abscess seen on corresponding CT image (right), thus defining soft-tissue infection without osteomyelitis. There was no evidence of vertebral osteomyelitis on follow-up CT 4 wk later.
Bar-shalom et al
Tc-99m leukoscan in infected TKR-Quigley in press 2008

- 32 studies performed for suspected knee infection
- 28 had prosthetic joint in situ
- 4 post surgery (not TKR) or suspected primary infection
- Mean age 64 years (range 21-91)
RESULTS-Quigley et al

- 11 true positives
- 13 true negatives
- 3 false negatives
- 1 false positive
- 79% sens, 93% spec

4 patients: data not available (1 died before diagnosis established, no PM)
One Hour Post Injection

Four Hours Post Injection
Is there a role for fusion imaging in infection/inflammation

- Potential for better localisation
- Potential for improved specificity
- Is high cost justified
- Will use of machines be taken up by more “trendy” topics such as cancer
- Will it be worth the effort
SPECT-CT or PET-CT?
What can we do with each machine

- SPECT-CT
- Tc-99m MDP
- Ga-67
- In-111 labelled WBCs
- Tc-99m HMPAO WBCs
- Tc-99m antibodies

- PET-CT
- F-18 FDG
- F-18 WBCs
Roach et al 2006 NMC

Looked at 50 scans including bone and Ga-67 SPECT-CT

16% of patients had minor change
11% major change c/w SPECT alone

Almost all to do with localisation and improved specificity

Specificity itself improved by 26%
Ga-67 in gall bladder abscess Ho et al ACR
Specific results for infection

- Inquie et al J Comp Assist Tom 2007
- 16 patients (11 In-111 WBC and 6 Ga--67)
- SPECT/CT images yielded "added value" for anatomical localization in 65%, diagnostic confidence in 71%, and altered interpretations in 47% of cases
Ga-67 in infected Tx
Case reports

- Most of the other publications are case reports
- Often in themselves interesting
- However poor level of evidence to convince those with the money!
Tc-99m HMPAO WBC in infected vascular graft  Held et al 2007 ACR
WBC SPECT-CT showing an infected iliac graft Bar Shalom et al. JNM 2006 48% more accurate than planar WBC imaging.
M, 57, S/a rt. fem-pop graft
Fever, leukocytosis, infected
lt. groin wound
SPECT/CT: graft involvement confirmed at surgery
Tc-WBC Imaging of Infected Vascular Graft

- Rt. iIio-femoral graft
- Swelling in rt. groin
- Negative blood culture
- Planar scan: abnormal uptake rt. inguinal region, increasing in intensity

SPECT/CT: uptake localized to vascular graft

Prepared by Dr. Paola Erba, Pisa
Tc-WBC scintigraphy vs conventional radiological imaging in management of late, low-grade vascular prosthesis infections

*Erba et al, EJNMMI 2014*

55 patients, susp. late & low grade graft infection

- Tc-WBC (planar +SPECT/CT)
- 47 graft infection, 8 extra-graft infectious foci
- Tc-WBC positive: 90% (43/47, 20/43 also extra-graft)
- SPECT/CT: reduced # FP in 37% patients

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>SPECT</td>
<td>85%</td>
<td>63%</td>
</tr>
<tr>
<td>SPECT/CT</td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td>US</td>
<td>34%</td>
<td>75%</td>
</tr>
<tr>
<td>CT</td>
<td>49%</td>
<td>83%</td>
</tr>
<tr>
<td>Clinical criteria</td>
<td>68%</td>
<td>63%</td>
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</table>
The Diabetic Foot – the Value of WBC-SPECT/CT

WBC scan:
- Pros: Diagnosis of infection
- Cons: not good enough [poor] for localization (to soft tissues and/or bone)

Solved with SPECT/CT!
- Single study
- Accurate spatial localization
  - extremities are less prone to motion
  - close proximity of structures in a small anatomic region
- Decreased radiation exposure; lower cost
Tc-WBC SPECT/CT Diabetic Foot
Skin ulcer, pus secreting, tenderness & swelling 1st right toe

Infected soft tissue ulcer, plantar aspect 1st right toe
No evidence of osteomyelitis 5 months follow up
WBC Scan in Diabetic Foot

Potential Pitfalls

Tc-WBC uptake in hyperdense foreign body secondary to soft tissue infection – no OM!
## WBC Imaging of the Diabetic Foot

### Summary of Literature

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Agent/Technique</th>
<th>Pts/sites</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fillippi</td>
<td>2009</td>
<td>Tc-WBC/SPECT/CT</td>
<td>17/19</td>
<td>Contribution of SPECT/CT: 53%</td>
<td></td>
<td></td>
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<tr>
<td>Heiba</td>
<td>2010</td>
<td>BS &amp; In-WBC (SPECT/CT) ± BM</td>
<td>213/?</td>
<td>95%</td>
<td>94%</td>
<td></td>
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<tr>
<td>Erdman</td>
<td>2012</td>
<td>Tc-WBC / SPECT/CT</td>
<td>77/100</td>
<td>Composite severity index: prediction of outcome</td>
<td></td>
<td></td>
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<tr>
<td>Capriotti</td>
<td>2006</td>
<td>WBC</td>
<td>Meta-analysis</td>
<td>90%</td>
<td>81%</td>
<td></td>
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<tr>
<td>Dinh</td>
<td>2008</td>
<td>In-WBC</td>
<td>Meta-analysis</td>
<td>74%</td>
<td>68%</td>
<td></td>
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<tr>
<td>Palestro</td>
<td>2009</td>
<td>Review</td>
<td></td>
<td>72-100%</td>
<td>67-98%</td>
<td></td>
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<tr>
<td>Asli</td>
<td>2011</td>
<td>Tc-IgG / planar</td>
<td>18/23</td>
<td>100%</td>
<td>69%</td>
<td>83%</td>
</tr>
</tbody>
</table>
Conclusions

- Increasing evidence for use of SPECT-CT
- Main advantage is Specificity
- May be some improvement in sensitivity
- Can be used with Ga-67, labelled WBCs and ABs