Utility of SPECT/CT scan for anatomical localization of pararectal and presacral sentinel nodes in prostate cancer

J.R. Chícharo de Freitas a, b, *, G.H. KleinJan b, c, H.G. van der Poel d, N.S. van den Berg b, c, E. Vegt b, M.P. Stokkel b, R.A. Valdés Olmos b, c

a Servicio de Medicina Nuclear, Hospital Clínico San Carlos, Madrid, Spain
b Department of Nuclear Medicine, Netherlands Cancer Institute, Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands
c Department of Radiology, Leiden University Medical Center, Leiden, The Netherlands
d Department of Urology, Netherlands Cancer Institute, Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Abstract

Aim: This study has aimed to evaluate the added value of SPECT-CT scan in the preoperative assessment of sentinel nodes of the presacral and pararectal regions localized outside the standard area of extended pelvic lymphadenectomy for the staging of the pelvis in prostate cancer. SPECT-CT scan can serve as a guide for the excision of these nodes by lymphadenectomy by open surgery or laparoscopy.

Materials and methods: We evaluated 4 patients with prostate cancer presenting sentinel nodes in the pararectal and presacral regions on SPECT-CT scan performed in addition to lymphoscintigraphy. These patients underwent lymphadenectomy with robot-assisted laparoscopy together with prostatectomy. All of the excised lymph nodes were sent for histopathology study.

Results: An average of 6 sentinel nodes per patient were found on SPECT-CT scan with a mean of 2 sentinel nodes in presacral/pararectal region. Lymphadenectomy including these areas was performed. Pararectal/presacral sentinel nodes of all patients depicted by SPECT-CT scan were tumor-free on histopathology study. Sentinel nodes (no pararectal/presacral) were positive for malignancy in only one patient.

Conclusion: Preoperative SPECT-CT scan is a useful tool to localize the sentinel nodes in pararectal/presacral regions. It can be an anatomic guide for new modalities of laparoscopic surgery such as robot-assisted procedures that can access the pelvic areas visualized with SPECT-CT scan, making excision of these nodes possible.
Introduction

Pelvic lymph node dissection is currently considered as the method of choice for regional staging in patients with apparently localized prostate cancer. This procedure is performed in the area of the obturator fossa since this region is traditionally considered to be the site of the first lymph node metastases. However, lymphatic drainage of the prostate varies and is often multidirectional. Extended pelvic lymph node dissection is therefore carried out in many centers including not only the lymph nodes of the obturator fossa but also those found along the external iliac, hypogastric and common iliac arteries and the presacral region. Bonilla-Damiá et al. visualized 14.4% of the sentinel lymph nodes localized in the presacral, pararectal and paravesical regions. None of these lymph nodes would have been removed with extended pelvic lymph node dissection, thereby resulting in inadequate staging.

The development of minimally invasive surgery and the contribution of sentinel lymph node procedures have become useful tools for reducing complications and increasing the accuracy of the detection and correct dissection of the lymph nodes. Single photon emission computed tomography (SPECT-CT) optimizes anatomical localization of the sentinel lymph nodes, mainly those outside the area of the extended lymph node dissection such as those in the presacral/pararectal region and others located along the aortic pathway or even close to the anterior abdominal wall.

Despite the many advantages of laparoscopic surgery due to its minimally invasive nature, with this procedure it is difficult to reach certain pelvic areas such as the presacral or pararectal regions which are more accessible with open surgery. Robot-assisted laparoscopic surgery therefore allows greater margins of maneuverability, improving access to these areas while maintaining the advantages of minimally invasive surgery.

We analyzed 4 patients presenting drainage to the presacral and/or pararectal regions in sentinel lymph node scintigraphy combined with SPECT-CT. Anatomical localization of these sentinel lymph nodes by the SPECT-CT was crucial to guide robot-assisted laparoscopy for resecting these lymph nodes and those in the pelvic lymph node dissection.

Materials and methods

We retrospectively evaluated 4 patients with prostate cancer (age range: 58–63 years) undergoing prostatectomy and robot-assisted lymph node dissection in the Netherlands Cancer Institute. The patients showed lymphatic drainage to the presacral and pararectal regions in the preoperative nuclear medicine images.

The patients were injected with a mean dose of 210 MBq of 99mTc-nanocolloid (range 189–234 MBq). Peri/intratumoral injections of 0.1 ml of the radiotracer were made in each quadrant of the prostate. Administration of the radiotracer was guided by transrectal ultrasonography. Table 1 shows the characteristics and histopathological results of the patients. Planar images were obtained at 15 min and 2 h after radiotracer injection. Following the delayed planar images SPECT-CT images were acquired with a hybrid camera (Symbia T; Siemens, Erlangen, Germany). SPECT acquisition (matrix 256 x 256, 60 frames, 20 s/frame) was made using 6 angular steps of 20 s/frame. For CT, 2 mm slices were obtained (130 keV, 17 mAs, B60 s kernel). After attenuation correction and dispersion, axial SPECT-CT images were reconstructed using the Osisoft 2000 (Siemens). Fusion images were made using an Osirix Dicom image viewer with a MAC OS X operative system.

The images were analyzed using multiplanar reconstruction with axial, coronal and sagittal slices. We also created 3D reconstruction using a volumetric representation to achieve global recognition of the sentinel lymph nodes in relation to the surrounding anatomical structures (Fig. 1). The first drainage lymph nodes to appear in the early planar images were considered to be sentinel lymph nodes. The lymph nodes which appeared in the delayed images at an intermediate site between the first drainage lymph nodes and the site of injection were also considered sentinel lymph nodes. The lymph nodes located cranially to those previously identified as sentinel lymph nodes were considered as secondary lymph nodes. On the other hand, lymph nodes detected only by the SPECT-CT at sites different to those observed in the planar images were also considered as sentinel lymph nodes.

The lymph node dissection with radio-guided extraction of the sentinel lymph node was performed with robot-assisted laparoscopy together with a gamma ray laparoscopic probe (Europrobe; Euro Medical Instruments). All the patients also underwent extended pelvic lymph node dissection. Following surgery the sentinel lymph nodes were sent for histopathological analysis.

Results

An average of 6 sentinel lymph nodes were found in the SPECT-CT, with a mean of 2 sentinel lymph nodes in the presacral and/or pararectal region. The 4 patients presented pararectal drainage with presacral sentinel lymph nodes in 2 patients (Figs. 2 and 3). In contrast to the planar imaging, SPECT-CT was able to very precisely localize the pararectal and presacral sentinel lymph nodes.

The extended pelvic lymph node dissection included the areas in which sentinel lymph nodes were identified. An average of 23 lymph nodes (range: 18–35) were resected in the extended pelvic lymph node dissection combined with the sentinel lymph node biopsy. Only one patient showed positive histopathological results of malignancy (3 sentinel lymph nodes and 4 non sentinel lymph nodes). The histopathological results of the pararectal/presacral sentinel lymph nodes localized by SPECT-CT in all the patients were tumor-free.

Discussion

In the initial evaluation of prostate cancer staging of the pelvic lymph nodes is very important. The gold standard for lymph node staging is open or laparoscopic lymph node dissection. The limits of the extension of lymph node dissection are controversial. The extension often covers the obturator fossa, an area traditionally considered as the primary site of lymph node metastasis. Nevertheless, many studies have demonstrated that 19–35% of lymph node metastases are localized outside this region.

Studies evaluating more extensive lymph node dissection have shown that dissection limited to only the obturator fossa misses around 50% of the lymph node metastases. Extended lymph node dissection includes not only the obturator fossa but also extends to the lateral edge of the external iliac vessels. Many

Conclusión: La SPECT-TC preoperatoria es una herramienta útil para localizar los ganglios centinelas en las regiones presacral y pararrectal, constituyendo una guía anatómica que puede ser de ayuda para nuevas modalidades de cirugía laparoscópica como los procedimientos asistidos por robot, los cuales pueden acceder a estas áreas permitiendo la escisión de dichos ganglios.

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Table 1
Clinical characteristics and findings of the preoperative images of the patients included in the study.

<table>
<thead>
<tr>
<th>Patient</th>
<th>TNM</th>
<th>Total sentinel lymph nodes in SPECT/CT</th>
<th>Pararectal/presacral sentinel lymph nodes in SPECT/CT</th>
<th>Histopathology of all the lymph nodes (sentinel/non sentinel)</th>
<th>Histopathology pararectal/presacral lymph nodes</th>
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<tr>
<td>1</td>
<td>cT2dN0M0</td>
<td>5</td>
<td>2</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>2</td>
<td>cT2aN0M0</td>
<td>9</td>
<td>3</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td>3</td>
<td>cT3bN0M0</td>
<td>7</td>
<td>3</td>
<td>Positive (3/7 sentinel)</td>
<td>Negative</td>
</tr>
<tr>
<td>4</td>
<td>cT2aN0M0</td>
<td>3</td>
<td>1</td>
<td>Negative</td>
<td>Negative</td>
</tr>
</tbody>
</table>

centers perform extended field lymph node dissection which includes the lymph nodes in the obturator fossa as well as those along the external iliac, hypogastric and common iliac arteries and finally, the presacral region. In an article published in December 2012, Png and Koch described that the model used in their center included these same regions in addition to the pararectal lymph nodes.13

Sentinel lymph nodes are lymph nodes which drain directly from the injection site in the prostate and are therefore the first lymph nodes for primary tumor metastasis.2,14 Due to the low index of false negative results6 if the sentinel lymph nodes are free of tumor cells, pelvic lymph node dissection may be avoided. Compared with lymph node dissection sampling of the sentinel lymph nodes is a less invasive procedure with less morbidity and also allows the analysis of lymph nodes localized outside the area of the pelvic lymph node dissection.15,16 Biopsy of the sentinel lymph node in prostate cancer has been validated using laparoscopic surgery as well as open surgery combined with prostatectomy.17 The Augsburg group validated this procedure, reporting a high sensitivity and a false negative rate of 5.9%.6

![Fig. 1.](image1.png)

(A) SPECT-CT with volumetric 3D reconstruction showing drainage at both sides of the pelvis. The most caudal deposit of the radiotracer is seen in the axial projection of the SPECT-CT as a pararectal sentinel lymph node (B). In the CT (C) the pararectal deposit corresponds to a lymph node which is not increased in size (circle).

![Fig. 2.](image2.png)

The planar image obtained 2 h after radiotracer administration (A) does not show drainage from the injection site to any lymph node. In contrast, the SPECT-CT image (B) shows a left pararectal sentinel lymph node (arrow) which is increased in size in the CT (circle).
The addition of SPECT-CT to lymph node dissection allows in-depth anatomical localization of the sentinel lymph nodes in relation to the lymph node stations in the pelvis.\textsuperscript{16} SPECT-CT is particularly useful in detecting sentinel lymph nodes located outside the area of extended lymph node dissection and for viewing sentinel lymph nodes not observed in the lymphoscintigraphy such as those in the pararectal and presacral regions. Similar to the literature, the anatomical information provided by SPECT-CT in our study localized and allowed resection of the sentinel lymph nodes in the presacral and/or pararectal regions in the 4 patients included.

Meinhardt et al. demonstrated that in 31\% of the patients the sentinel lymph nodes resected outside the area of the extended pelvic lymph node dissection were found at the following sites: presacral, Cloquet node, inguinal, paraaortic, abdominal wall, pararectal, behind the common iliac artery and lateral to the external iliac artery. Laparoscopic dissection of lymph nodes along the drainage pathway toward the pararectal nodes has often been reported to be difficult and of high risk.\textsuperscript{17}

Vermeeren et al. evaluated the use of SPECT-CT in the detection and localization of sentinel lymph nodes in prostate cancer, classifying these lymph nodes into 3 categories: no added value, with presumed added value and with definitive added value. SPECT-CT found additional sentinel lymph nodes in 63\% of the patients. Sentinel lymph nodes were found outside the area of extended pelvic lymph node dissection in 35\% of the patients. SPECT-CT had no added value in 13\% of the patients, had presumed added value in 24\% and definitive added value in 63\%. The sentinel lymph nodes were only detected by SPECT-CT in 56\% of the cases.\textsuperscript{18}

Ganswindt et al. found that the most common sites of localization of the sentinel lymph nodes were: external iliac (34.3\%), internal iliac (17.9\%), common iliac (12.7\%), presacral (8.6\%), pararectal (6.2\%) and paraaortic (right 5.3\%, left 5.3\%).\textsuperscript{19} Joniau et al. demonstrated that 44\% of the sentinel lymph nodes were localized outside the field of the extended pelvic lymph node dissection with 6\% in the presacral or paraaortic region.\textsuperscript{20} Weckermann et al. found sentinel lymph nodes outside the obturator fossa in 63\% of the cases.\textsuperscript{15} In the study by Bonilla et al., 94.4\% of the patients had sentinel lymph nodes outside the obturator region (14.4\% in presacral, pararectal and paravesical regions). Standard pelvic lymph node dissection is therefore not sufficient for precise staging, with some lymph nodes not being adequately detected.\textsuperscript{1}

Access by laparoscopy to certain anatomical areas such as the presacral and pararectal areas in the pelvic region is complicated, making lymph node resection difficult. Moreover, possible hemorrhage related to the presacral venous plexus (richly vascularized region) may be difficult to control and may compromise these areas.

The introduction of robotic equipment in recent years has helped to overcome many limitations in pelvic laparoscopic surgery. This equipment allows excellent definition, stereoscopic vision, clear visualization of the surgical field and perception of depth. Compared with traditional laparoscopy, robotic devices allow more precise movement with added improvement in the ergonomy. Robot-assisted surgery now allows the localization and resection of presacral and pararectal lymph nodes, providing advantages over traditional laparoscopic surgery.

With these advantages, in the present study robot-assisted laparoscopy led to excision of the sentinel lymph nodes located in the pararectal and presacral regions, none of which presented metastasis. In the only patient with positive lymph nodes, the pararectal sentinel lymph nodes were not affected. Nonetheless, the small number of patients analyzed makes further studies necessary to validate the specific role of this new approach. The use of preoperative SPECT-CT outside the pararectal and presacral regions extends to all the lymph nodes located outside the zone of extended pelvic lymph node dissection, providing a roadmap for surgical resection.

**Conclusion**

SPECT-CT is a useful tool which provides added value to the localization of pararectal and presacral sentinel lymph nodes. Lymphatic mapping and in-depth anatomical localization of the
sentinel lymph nodes obtained with preoperative images may be a useful guide for sentinel lymph node procedures using advanced techniques such as robot-assisted surgery which allows access to more complex areas of the pelvis with potential benefits for the patients.

Conflict of interests

The authors declare no conflict of interest.

Acknowledgements

We gratefully acknowledge the invaluable help of Antoni van Leeuwenhoek and especially Dr. Renato Valdés Olmos, and the working team from the Netherlands Cancer Institute.

References