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Original

An innovative multimodality approach for sentinel node mapping and biopsy in head and neck malignancies

M. Borbón-Arce[a,b,*], O.R. Brouwer[a], N.S. van den Berg[b,d], H. Mathéron[b], W.M.C. Klop[c], A.J.M. Balm[c], F.W.B. van Leeuwen[b,c], R.A. Valdés-Olmos[b,d]

[a] Servicio de Medicina Nuclear, Hospital Universitario Virgen Macarena, Sevilla, España
[b] Department of Nuclear Medicine, The Netherlands Cancer Institute, Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands
[c] Department of Head & Neck Surgery and Oncology, The Netherlands Cancer Institute, Amsterdam, The Netherlands
[d] Department of Radiology, Leiden University Medical Centre, Leiden, Netherlands

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ABSTRACT

Purpose: Recent innovations such as preoperative SPECT/CT, intraoperative imaging using portable devices and a hybrid tracer were evaluated in a multimodality approach for sentinel node (SN) mapping and biopsy in head and neck malignancies.
Material and methods: The evaluation included 25 consecutive patients with head and neck malignancies (16 melanomas and 9 oral cavity squamous cell carcinomas). Patients were peritumorally injected with the hybrid tracer ICG-^{99m}Tc-nanocolloid. SNs were initially identified with lymphoscintigraphy followed by single photon emission computed tomography (SPECT/CT) 2 hours after tracer administration. During surgery a portable gamma camera in combination with a near-infrared fluorescence camera was used in addition to a handheld gamma ray detection probe to locate the SNs.
Results: In all patients the use of conventional lymphoscintigraphy, SPECT/CT and the additional help of the portable gamma camera in one case were able to depict a total of 67 SNs (55 of them visualized on planar images, 11 additional on SPECT/CT and 1 additional with the portable gamma camera). A total of 67 of the preoperatively defined SNs together with 22 additional SNs were removed intraoperatively; 12 out of the 22 additional SNs found during operation were located in the vicinity of the injection site in anatomical areas such as the periauricular or submental regions. The other 10 additional SNs were found by radioguided post-resection control of the excision SN site.
Conclusion: In the present series 26% additional SNs were found using the multimodal approach, that incorporates SPECT/CT and intraoperative imaging to the conventional procedure. This approach appears to be useful in malignancies located close to the area of lymphatic drainage such as the periauricular area and the oral cavity.

Técnica mutimodalidad innovadora en el abordaje de la biopsia selectiva del ganglio centinela en tumores de cabeza y cuello

Palabras clave:
Abordaje multimodalidad
Ganglio centinela
Cabeza y cuello
SPECT/TAC
Melanoma
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RESUMEN

Objetivo: Se ha evaluado innovaciones recientes como la SPECT/TAC, dispositivos portátiles de imagen intraoperatorios y un trazador híbrido en el contexto de un abordaje multimodalidad para el mapeo y biopsia del ganglio centinela (GC) en tumores de cabeza y cuello.
Material y métodos: Se evaluaron 25 pacientes consecutivos con tumores de cabeza y cuello (16 melanomas y 9 carcinomas de células escamosas). Se inyectaron peritumoralmente con el trazador híbrido ICG-^{99m}Tc-nanocoloide. Los GC se identificaron inicialmente mediante imágenes planares y a las 2 horas postinyección del trazador se realizó una SPECT/TAC. Intraoperatoriamente se utilizó una gammacámara portátil en combinación con una cámara infrarroja de fluorescencia y una sonda detectora de rayos gamma para localizar los GC.
Resultados: En todos los casos las imágenes planares, la SPECT/TAC, y en un caso con la gammacámara portátil, se lograron identificar un total de 67 GC (55 con las imágenes planares, 11 adicionales con la SPECT/TAC y uno con la gammacámara portátil). Además de los 67 previamente definidos, se identificaron y extrajeron 22 GC adicionales intraoperatoriamente de los cuales 12 se encontraban cerca del punto de inyección en zonas como las regiones periauricular y submandibular. Los 10 restantes se encontraron mediante control radioguiado del lecho ganglionar postextracción.

* Corresponding author. Hospital Universitario Virgen Macarena Sevilla, Avenida Dr. Fedriani 3, 41009, Sevilla España. Servicio de Medicina Nuclear. Tel.: +0034 955008929.
E-mail address: m_borbon@hotmail.com (M. Borbón-Arce).

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Conclusión: En nuestra serie se encontraron un 26% de GC adicionales. Este abordaje multimodalidad parece ser útil en tumores en los que el drenaje linfático es muy próximo al sitio de inyección como en la región periauricular y en cavidad oral.

Introduction

Sentinel node biopsy (SNB) in the head and neck area is usually more challenging than in other areas, because of its complex anatomy, the presence of numerous vital structures and the variable drainage patterns in this region[1].

Previous studies suggest that malignant head and neck tumours such as melanoma and squamous cell carcinoma (SCC) of the oral cavity can obtain important benefit of the SNB. Even in the era of emerging tumour-imaging modalities, such as positron emission tomography (PET), SNB is considered the most reliable method for identifying micro-metastatic disease in regional lymph nodes[2]. Preliminary information suggests that there is a survival benefit if a node dissection is done at an early stage and has proven to provide relevant prognostic information and is widely performed to accurately stage melanoma patients[3,4]. In SCC of the oral cavity, the use of SNB may avoid an unnecessary elective neck dissection in 70-80% of the cases[5,6]. Positive sentinel nodes (SNs) have shown to be a negative prognostic factor in oral cancer[7] and several authors have published good results regarding staging accuracy of the SNB in this group of patients[8,9].

The contribution of nuclear medicine to the SN procedure has been based on lymphoscintigraphy for preoperative lymphatic mapping and the use of a handheld gamma ray probe for intraoperative SN detection. However, the head and neck is an area of complex anatomy, SNs in this region can be difficult to localize with conventional planar lymphoscintigraphy because is not able to visualize the three-dimensional structures of the head, doesn't help us with the description of unexpected drainage patterns, and is not unusual to find SNs very close to the injection site that can be missed on this images. A few years ago SPECT/CT was introduced to anatomically localize SNs. Also it is well known that with the help of SPECT/CT more SNs can be identified compared to conventional scintigraphy[10–13].

Intraoperative SN detection with the handheld gamma ray probe can be complicated as well. More than 95% of the administered radioactivity stays behind at the injection site and may cause nearby SNs to be missed[14], no overview can be provided, so certainty about removal of all radioactive nodes cannot be confirmed. In the last years with the availability of portable gamma cameras, an overview of all radioactive hotspots in the surgical field is possible. Its position can be easily adjusted and approximated to a milimetric distance from the injection site to check if there are SNs close to this area. Differentiation between SNs and second echelon nodes is facilitated because of the camera's capability of radioactivity quantification and also pre-surgical scintigraphic images can be compared with later ones during the intervention.

A third innovation in the SN procedure has been the introduction of the hybrid tracer ICG ^{99m}Tc-nanocolloid[15]; in this tracer ICG adopts the lymphatic migration properties of the radiocolloid, resulting in a significantly longer retention time in the SNs as compared to ICG alone. Also ICG is not visible by the naked eye and as such does not interfere with the visual identification of tumour borders. With this hybrid tracer being both radioactive and fluorescent, preoperative surgical planning can be combined with intraoperative radio and fluorescence guidance towards the SNs. The fluorescent properties of the hybrid tracer extend the radioguided procedure by providing real-time optical localization using a handheld near- infrared (NIR) fluorescence camera[15,16].

Table 1
Melanoma patients and tumour characteristics.

Characteristic	Value
Age, mean (range), years	58 (41-77)
Genre, no. of patients (%)	
Male	9 (56)
Female	7 (44)
Melanoma site, no. of patients (%)	
Face	7 (44)
Scalp	7 (44)
Ear	2 (12)
Breslow thickness, mm	
Median	2.0
Mean	2.7
Range	1.0-6.0

The main purpose of the present study was to evaluate a protocol of SN detection including these recent innovations in a multimodality approach for SN mapping and biopsy in patients with head and neck malignancies

Patients and methods

Patients

The evaluation included 25 consecutive patients. Sixteen patients with melanoma of the head and neck with a Breslow-thickness of at least 1 mm or Clark level IV (Table 1) and nine patients with oral cavity squamous cell carcinoma (SCC) with T1/2 tumours (Table 2). For both melanoma and oral cavity cancer lymphatic mapping is a routine procedure at our institute and informed consent was obtained in all patients. Ultrasound of the neck and parotid region was routinely carried out and was combined with fine needle aspiration cytology in case of a suspicious node.

Preoperative imaging

After the preparation of ^{99}mTc-Nanocolloid (GE Healthcare, Eindhoven, The Netherlands), hybrid ICG-^{99}mTc- nanocolloid was formed using a dose of 0.25 mg of ICG (ICG-Pulsion,Pulsion Medical Systems, Munich, Germany) as previously described[15,16].

Table 2
Squamous cell carcinoma patients and tumour characteristics.

Characteristic	Value
Age, mean (range), years	60 (52-71)
Genre, no. of patients (%)	
Male	6 (67)
Female	3 (33)
Tumor site, no. of patients (%)	
Tongue R	3 (33)
Tongue L	2 (22)
FOM midline	3 (33)
FOM R	1 (12)
TNM, no. of patients (%)	
T1	6 (67)
T2	3 (33)

FOM floor of the mouth, *R* right, *L* left.