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Original article

Gamma probe guided surgery for osteoid osteoma: Is there any additive value of quantitative bone scintigraphy?

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ABSTRACT

Objective: The aim of this study is to evaluate the efficiency of gamma probe guided osteoid osteoma surgery and the applicability of quantitative analyses obtained from preoperative bone scan images.
Material and methods: This study involved 12 osteoid osteoma patients who were treated with gamma probe guided surgery after preoperative bone scan. The calculated contrast ratios between nidus and adjacent healthy bone from preoperative bone scan and the calculated percentages of count reduction after resection of nidus during intraoperative gamma probe application were compared. Patients were followed up for any recurrence or complications.
Results: The mean contrast ratio between nidus and adjacent healthy bone calculated from preoperative bone scan was 43.6% (range 33-53%). Following the nidus excision, an average of 55.8% (range 28-73%) count reduction was estimated with gamma probe in the tumor area. There was no correlation between preoperative scintigraphic contrast ratio and intraoperative gamma probe count reduction ratio ($r = 0.46$, $p = 0.13$). Complete cure was achieved in 11 (92%) patients with single operation, during the postoperative follow up period. None of the patients had any major or minor complications during or after the surgery.
Conclusions: Due to high clinical success and low complication rate in osteoid osteoma surgery, gamma probe application is an effective and safe method that should be used more extensively in daily practice.

Cirugía del osteoma osteoide guiada por sonda gammadetectora: ¿existe un valor adicional de la gammagrafía ósea cuantitativa?

Palabras clave:
Osteoma osteoide
Sonda gammadetectora
Gammagrafía ósea

RESUMEN

Objetivo: El objetivo de este estudio es evaluar la eficiencia de la sonda gammadetectora en la cirugía radioguiada del osteoma osteoide y la aplicabilidad del análisis cuantitativo obtenido a partir de las imágenes de la gammagrafía ósea preoperatoria.
Material y métodos: Este estudio incluye a 12 pacientes con osteoma osteoide quienes fueron tratados con cirugía radioguiada por sonda gammadetectora después de la gammagrafía ósea preoperatoria. Se compararon las relaciones de contraste calculadas entre el nidus y el hueso sano adyacente en la gammagrafía ósea y los porcentajes de reducción de cuentas tras la extirpación quirúrgica del nidus. Los pacientes fueron sometidos a seguimiento para detectar recurrencia o complicaciones postoperatorias.
Resultados: La relación media de contraste entre el nidus y el hueso sano adyacente fue de 43,6% (rango de 33-53%). Tras la excisión del nidus, se estimó mediante la sonda una reducción media de 55,8% (rango de 28-73%) en las cuentas detectadas en el área de tumor. No había ninguna correlación entre ambas relaciones ($r = 0{,}46$, $p = 0{,}13$). Se alcanzó una curación completa en 11 pacientes (92%) con una única operación, durante el período de observación postoperativo. Ninguno de los pacientes tuvo alguna complicación menor o mayor durante o después de la cirugía.
Conclusiones: Debido a su elevada eficacia clínica y al bajo número de complicaciones quirúrgicas, la aplicación de la sonda gammadetectora en la cirugía del osteoma osteoide es un método efectivo y seguro. más extensivamente en la práctica diaria.

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Introduction

Osteoid osteoma is a benign bone tumor, which mainly affects long bones of children and young adults. This tumor consists of a central round or oval-shaped nidus and a sclerotic bone zone surrounding it.[1,2]

The diagnosis of osteoid osteoma is based on clinical, radiologic and scintigraphic findings. Bone scintigraphy is one of the best methods for the diagnosis of osteoid osteoma and for identifying the precise localization of the nidus.[2,3]

The treatment of osteoid osteoma is achieved with complete excision or destruction of the nidus. It is difficult to identify the nidus by direct visualization or palpation during operation, therefore intraoperative localization of the tumor is of high importance. Incomplete excision of the nidus may result in recurrence in the post-operation period. Wide resection applied to weight-bearing bones in order to minimize the risk of recurrence may also cause bone weakening and increase the risk of fracture as well.[1,2,4,5]

To prevent extensive resection and minimize mortality and morbidity, a precise intraoperative localization of the nidus and confirmation of complete resection is highly important. To serve this aim, several localization methods such as intraoperative nuclear medicine methods, tetracycline fluorescence and imaging-guided methods have been used in practice.[1,2,6,7] Although not very common, gamma probe guided method has been used in patients with osteoid osteoma since 1980.[8,9] Gamma probe is very successful in intraoperative localization of the nidus, which has the highest count measurement.[6,7,10] Nidus localization is followed by the count measurement of the adjacent healthy bone in gamma probe guided osteoid osteoma surgery. This adjacent count value is used as the reference value to terminate the resection, and is regarded as proof of complete resection of the nidus. Nevertheless, the gamma probe counts of nidus and adjacent healthy bone, especially those obtained from lesions that are located in the bone localizations with complex geometric structures may vary widely. This may cause hesitation about the exact localization or about adequacy of excision.

Regarding these findings the aim of our study is to attract attention to gamma probe guided osteoid osteoma surgery, since it is not a widely applied or a well-known method, to find out the efficiency of gamma probe guided osteoid osteoma surgery, and evaluate the applicability of quantitative analyses obtained from preoperative scintigraphic images in order to determine the reference count value to finalize the gamma probe guided operation.

Materials and methods

Patients

Twelve patients with the diagnosis of osteoid osteoma who were treated with gamma probe guided surgery in Kocaeli University Hospital between 2009 and 2011 were analyzed in this prospective study. The study was approved by the institutional ethical committee, and written informed consent was obtained from all the participating patients.

Preoperative diagnostic imaging

Whole body bone scintigraphy was performed in all the patients in order to verify the diagnosis and determine the precise localization of the nidus. Adult patients received intravenous injection of 740 MBq ^{99m}Tc-methylene diphosphonate (^{99m}Tc-MDP), and the children's doses were adjusted according to their weights. Two-three hours following injections, a whole body scan and static images in anterior and posterior positions were obtained with a two-headed gamma camera system (Infinia, GE Medical Systems, Milwaukee, WI, USA) equipped with low energy, high resolution, and parallel-hole collimators. Thin-section computed tomography was performed in only 8 patients.

Quantification of ^{99m}Tc-MDP uptake on diagnostic scintigraphy

In the preoperational period, diagnostic scintigraphic images obtained from the gamma camera (GC) were evaluated semi-quantitatively in the anterior or posterior views. Whether anterior or posterior; the image with the highest lesional activity accumulation was used.

On static scintigraphic images, elliptical regions of interest (ROI) of a median size of 2.7 cm^2 were drawn to the area where the nidus was located with the highest point of activity and to the adjacent healthy bone by semi-automatic method. Commercially available software was then used to quantify the maximum of counts within the nidus region (GC N) and the adjacent healthy bone region (GC Adj). In order to estimate the count reduction percentage during gamma probe application, the contrast ratio between the nidus and the adjacent healthy bone was calculated with the following formulation: $(GC\,N - GC\,Adj)/GC\,N \times 100$. However, these calculations obtained from bone scintigraphic images were not used during surgeries.

Gamma probe guided surgery

^{99m}Tc-MDP was injected intravenously at the doses used for diagnostic imaging to all the patients approximately 1 h before the surgical procedure. About 15 min after the injection, the skin overlying the nidus where the highest activity accumulation was observed, was marked with permanent ink with the help of a point cobalt-51 source under the gamma camera. Urinary catheterization was performed on the patients with lesions in or around the pelvic area in order to reduce the background activity which may come from the bladder.

All the patients were taken to the operating room for complete excision of osteoid osteoma under general anesthesia. All of the operations in our study were performed by the same surgeon. The surgeon was guided by a nuclear medicine specialist, who was experienced in using the gamma probe, during the operation. A hand-held gamma probe (Crystal Probe 2000, Berlin, Germany) with thallium-activated cesium iodide (CsI:Tl) crystal (diameter 15 mm) was used for the detection and excision of the osteoid osteoma intraoperatively (Fig. 1). The affected bone was reached

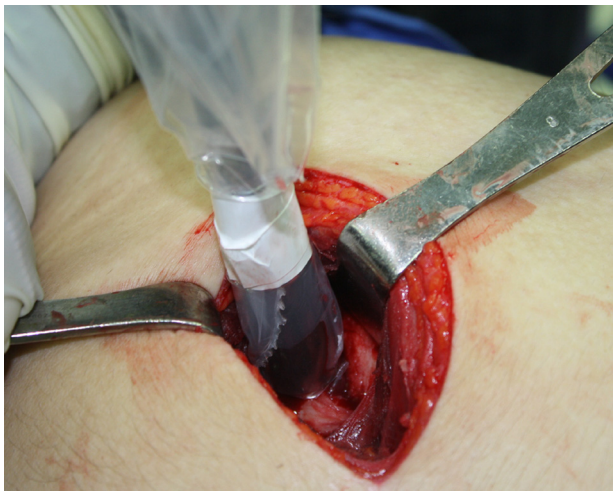

Fig. 1. The gamma probe in use during an osteoid osteoma surgery.