INTRAOPERATIVE GAMMA HAND-HELD PROBE NAVIGATION IN RESECTION OF OSTEOID OSTEOMA TUMOR – REPORT OF TWO CASES

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SUMMARY – Two cases of osteoid osteoma tumor (OO) are presented and our early experience with intraoperative gamma probing to localize OO during surgery is reported. The concept of radioguided surgery was developed 60 years ago and the gamma detection probe technology for radioguided biopsy and/or resection of bone lesions has been applied since the early 1980s. Bone scintigraphy is very important for initial diagnosis of OO with almost 100% sensitivity. The bone scan finding is specific, with so called double density appearance, very intense accumulation of radiopharmaceutical in the nidus and therefore great difference between the nidus and the surrounding healthy bone, thus making possible to treat this lesion with probe guided surgery. Three phase bone scintigraphy and single photon emission computed tomography were conducted in our patients for initial diagnosis of OO. A second bone scintigraphy was performed before surgery. The surgery followed 12-15 hours later by intraoperative nidus detection with a hand-held gamma probe. Gamma hand-held probe is a system that detects gamma photons. The count rate in the nidus area on the day of surgery was 3 to 4 times higher than in the healthy bone area. Drilling was performed until the counts decreased to the level of the surrounding bone counts, thereby confirming complete excision. This is the method of choice for minimizing bone resection, the risk of pathologic fracture, the need of bone grafting, and reducing the period of convalescence. Evidence for the treatment efficiency is pain disappearance after the surgery.

Key words: *Osteoid osteoma; Tumor; Bone neoplasms; Intraoperative care*

Introduction

Osteoid osteoma (OO) is the third most common benign osteoblast tumor, first described by Jaffe in 1935 as a transformed sclerotic bone tissue with osteolytic part in the center, called nidus. The incidence of OO is 10%-12% of benign bone tumors and 3% of all primary bone tumors, with the most frequent localization in proximal femur and tibia (50%), but OO has been described in virtually all bones except for sternum[1]. It mostly occurs in children and young adults, but it can also be found in older individuals and is more common in men.

The pathognomonic symptom of OO is night pain relieved by non-steroidal anti-inflammatory drugs. The diagnosis of OO is based on clinical, radiographic and scintigraphic findings. Many patients have pain for months or years until the lesion is discovered. The classic radiographic presentation is a small geographic

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(well defined margin; non-aggressive) lesion no greater than 2 cm in diameter in cortical layer of the long bone. The lesion is surrounded by intense reactive sclerosis[2]. Bone scintigraphy is the best method for localization. The classic scintigraphic double density appearance is very specific for OO and is used as a guide for a dedicated computerized tomography (CT) study. False negative descriptions of OO have been reported on scintigraphic images, but these situations are rare and may occur when the nidus is smaller than 5 mm with minimal reactive sclerosis or in a patient previously submitted to bone manipulation[3].

Method

Gamma hand-held probe is a system that detects gamma photons. The control unit is connected with the hand-held probe by cable. Sterile drape prevents direct contact with operating field. The results are displayed digitally in counts *per* second and as audible signal demonstrating the lesion and providing output information to the surgeon. The method allows the surgeon to minimize the invasiveness and thus avoid complications.

Bone scintigraphy is very important for the initial diagnosis of OO with almost 100% sensitivity. The bone scan finding is specific, so called double density appearance, very intense accumulation of radiopharmaceutical in the nidus and therefore great difference between the nidus and the surrounding healthy bone, which makes possible to treat this lesion with probe guided surgery.

Three phase bone scintigraphy and single photon emission computed tomography (SPECT) were conducted in our patients for the initial diagnosis of OO. A second bone scintigraphy was performed before surgery. We used "second day protocol": one day before surgery the patients were injected with 666 MBq (18 mCi) and 555 MBq (15 mCi) 99mTc-diphosphonate, respectively. A permanent ink mark was drawn over the skin area with highest count rate to indicate the surgical approach. The surgery followed 12-15 hours later by intraoperative nidus detection with hand-held gamma probe.

On the day of surgery, the count rate was 3 to 4 times higher in the nidus area than in the healthy bone area. Drilling was performed until the counts decreased to the level of the surrounding bone counts,

Figs. 1 and 2. Drilling was performed until the counts decreased to the level of the surrounding bone counts, thereby confirming complete excision.

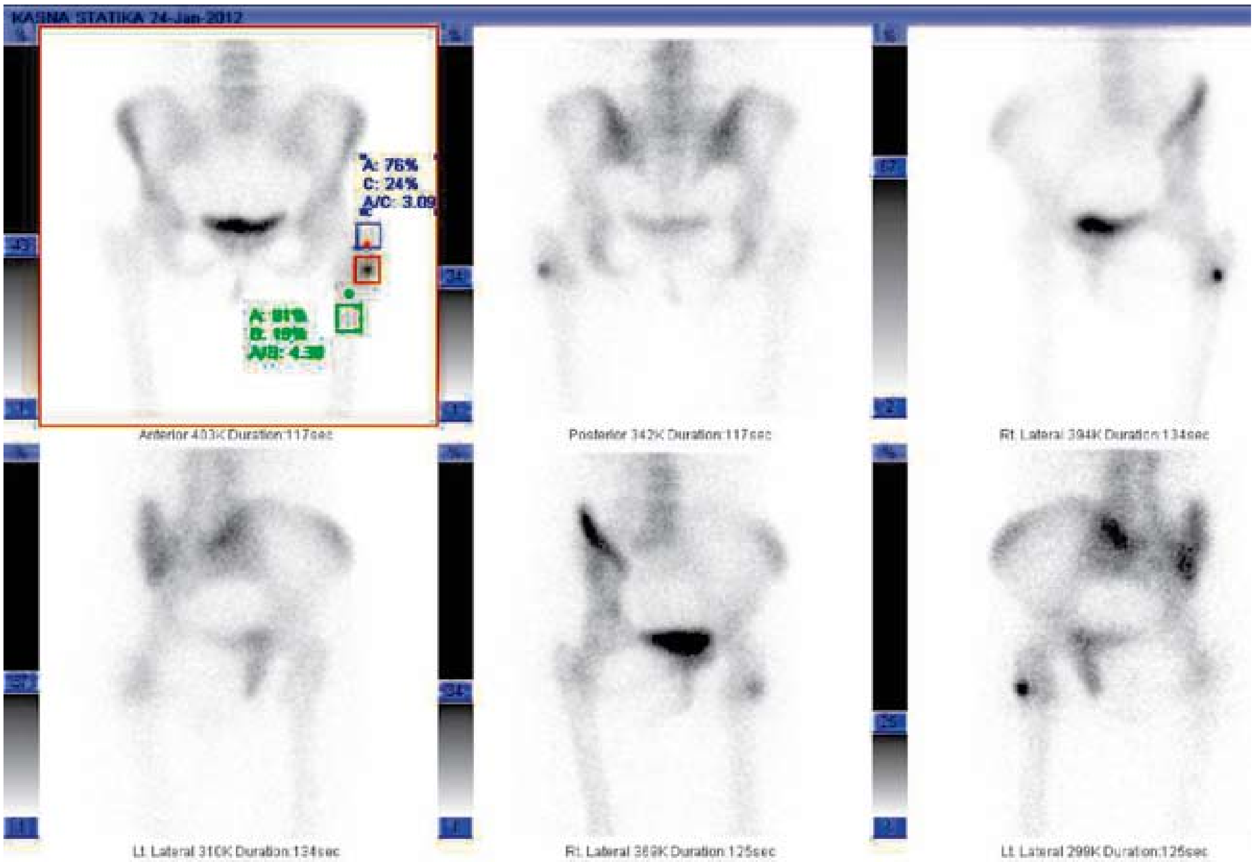

Fig. 3. A 25-year-old female patient: bone scintigraphy scan.

thereby confirming complete excision (Figs. 1 and 2). It is not necessary to remove the sclerotic bone reaction.

Case Reports

We present two cases of OO and report our early experience with intraoperative gamma probing to localize OO during surgery.

A 25-year-old female patient presented to the department complaining of severe left hip pain, which worsened during the night. At the time of first examination, inspection of the hip region showed neither signs of swelling not any other signs of pathologic changes. On palpation, there was no sensation of pain. Hip movements were full in all directions. Inner rotation was painful. The hip x-ray in anterior-posterior and lateral-lateral projection showed sclerotic changes in the proximal part of the femur, however, with no reactive changes. Initial diagnosis of OO of proximal femur was set. The diagnosis was confirmed by bone scintigraphy that showed double density appearance with the nidus located in the distal part of the great trochanter anterolaterally (Fig. 3).

A 28-year-old male patient presented with the same symptoms localized in the middle third of the right tibial bone. At the time of first examination, inspection of the knee and tibial region showed neither signs of swelling nor any other signs of pathologic changes. On palpation, there was no sensation of pain. Knee and ankle movements were full in all directions. The tibia x-ray in 2 projections showed sclerotic changes in the mid-third of the tibia, with no reactive changes. Initial diagnosis of OO of tibia was set. The diagnosis was confirmed by bone scintigraphy, which showed double density appearance with the nidus in the posterior part of the tibia (Fig. 4).

After surgery, the patients were admitted to the department where initial physical therapy was conducted. Outpatient follow up of our patients revealed

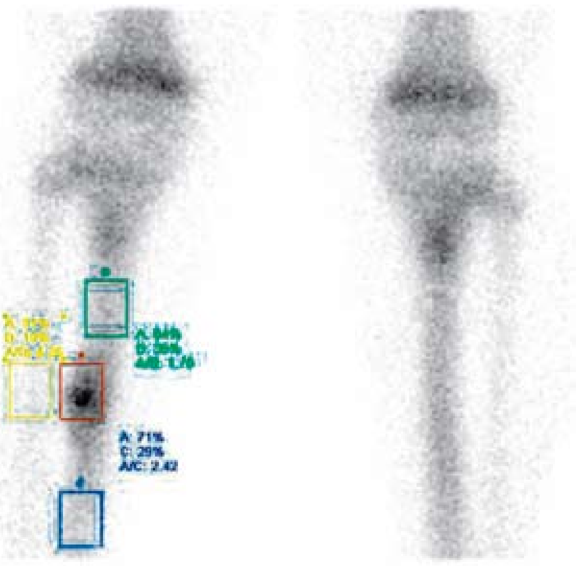

Fig. 4. A 28-year-old male patient: bone scintigraphy scan.

that night pain as the leading OO symptom had resolved, thus confirming successful procedure.

Discussion

The concept of radioguided surgery was developed 60 years ago and it is a surgical technique that enables the surgeon to identify the tissue "marked" preoperatively by a radionuclide, based on the characteristics of the tissue, the radioactive tracer and its carrying molecule, or the affinity of both. The radiopharmaceutical (99mTc diphosphonate) is administered by peripheral intravenous injection in a dosing range of approximately 15 mCi (555 MBq) to 30 mCi (1110 MBq) at a time approximately 2 to 12 hours prior to the planned surgical procedure. Reasonable success has been reported with guiding diagnostic biopsy of OO lesions as well as guiding the surgeon for complete surgical resection of such lesions[4]. The application of gamma detection probe technology for radioguided biopsy and/or resection of bone lesions in the early 1990s truly represented some of the early forward thinking that contributed to the later development of the modern era of radioguided surgery. For the radioguided biopsy and/or resection of bone lesions, the same radiopharmaceutical is used (99mTc diphosphonate) with the same dosing range as in diagnostic procedure[5]. Plain radiography does not always discern clearly between tumor tissue and reactive sclerotic bone in OO, especially when the nidus is near bone surface, which causes periosteal reaction. CT scanning and CT-guided excision or ablation of the tumor have been used but results are not entirely satisfactory[6]. Accurate localization and complete removal of the nidus is the key to successful treatment. More extensive surgery has been associated with postoperative stress fracture or growth disturbance[7,8]. The use of gamma detection probe in radioguided surgery is the method of choice because of preserving more bone tissue, minimizing the risk of pathologic fractures and the need of bone grafting, and for shortening the period of convalescence. Open surgery is still most frequently performed for OO resection and it is necessary sometimes, for example, when the nidus is located near vital structures[2,9]. Bone scintigraphy followed by intraoperative nidus detection with a hand-held gamma probe is the method that aggregates at least three advantages: it gives the surgeon precision when resecting OO, the procedure can be performed in the vicinity of vital structures, and radiation level is lower in comparison to patients treated with CT-guided procedures[3]. There are no exact data for the radiation exposure in OO radioguided surgery. Comparing it with other radioguided procedures performed with similar activities of 99mTc-labeled radiopharmaceutical agents and similar mean operative time, the data support the fact that the radiation exposure to surgical personnel members is low, especially because of the second day protocol we use. The values are beyond 10 micro Sv[10]. The remark of lacking histological proof could be ignored because of typical clinical, CT and scintigraphic findings. It is important to emphasize that this technique requires an efficient collaboration between nuclear medicine specialist and orthopedic surgeon.

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Sažetak

INTRAOPERACIJSKA NAVIGACIJA DETEKCIJSKOM GAMA SONDOM KOD RESEKCIJE OSTEOIDNOG OSTEOMA – PRIKAZ DVAJU SLUČAJEVA

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U radu se prikazuju dva klinička slučaja kod kojih smo koristili detekcijsku gama sondu za intraoperacijsku navigaciju prilikom kiretaže tumora osteoidnog osteoma (OO). Zahvati su izvršeni na Klinici za traumatologiju Kliničkog bolničkog centra "Sestre milosrdnice". Koncept radionavigacije u kirurgiji razvijao se zadnjih 60 godina, a primjena tehnologije gama detekcijske sonde za biopsiju ili resekciju koštanih lezija datira od ranih osamdesetih. Uz RTG te kompjutoriziranu tomografiju scintigrafija kosti je jedna od najvažnijih metoda u dijagnostici OO, s gotovo 100%-tnom osjetljivošću. Za početnu dijagnozu učinjena je trofazna scintigrafija kosti i SPECT – jednofotonska emisijska kompjutorizirana tomografija. Druga scintigrafija kosti učinjena je prije zahvata. Operacija je uslijedila 12-15 sati kasnije uz intraoperacijsko otkrivanje gnijezda ručnom gama sondom. Na dan operacije brojčana vrijednost bila je 3-4 puta viša na mjestu lezije u odnosu na zdravu kost. Kiretaža tumora provođena je sve dok brojčana vrijednost nije pala na razinu vrijednosti okolne kosti, na taj način potvrđujući potpuno uklanjanje lezije. Ovo je jedna od metoda izbora liječenja OO, jer na najmanju mjeru svodi resekciju kosti te time smanjuje rizik od mogućih patoloških prijeloma i skraćuje razdoblje rekonvalescencije. Dokaz uspješnosti kirurškog zahvata bio je nestanak boli u operiranih bolesnika.

Ključne riječi: *Osteoidni osteom; Tumor; Koštane neoplazme; Intraoperacijska skrb*