Resection of Bone Tumor Guided by Gamma Probe and Evaluation of Postoperative Pain

Ressecção de tumor ósseo guiada por Gamaprobe e avaliação do quadro álgico pós-operatório

Alberto Ramos Gomes1 Felipe Younes Quatrin2 Nadiane Maciel Becker2 Ruan Carlo Zanella2,3
Thércio Murilo Souza Rocha3

1 Onco-orthopedics, Fundação Hospitalar de Blumenau, Hospital Santo Antônio, Blumenau, SC, Brazil
2 Orthopedics and Traumatology Department, Hospital Santo Antônio, Blumenau, SC, Brazil
3 Nuclear Medicine, Clínica Cintilius – Medicina Nuclear, Blumenau, SC, Brazil

Rev Bras Ortop 2020;55(1):115–120.

Address for correspondence Ruan Carlo Zanella, Rua Tobias Barreto, 263 - Apartamento 63 - Bairro Vila Nova, Blumenau, SC, 89035-070, Brasil (e-mail: ruan.zanella@gmail.com).

Abstract

Osteoid osteoma is a benign neoplasm commonly found in young men, but that can be found in every age, which affects mainly long bones, clinically characterized by continuous and limiting pain that is relieved by salicylates. It is a small lesion composed of immature osteoid tissue, central hypervascularization and surrounding sclerotic area. Its diagnosis is performed by the clinic and aided by imaging tests, such as common radiography and computed tomography. Radiography shows a central radiolucent lesion and peripheral sclerosis. The biopsy takes place only in cases of diagnostic doubt. Surgical treatment involves resection of the niche, providing greater symptomatic relief, as well as percutaneous techniques. The technique of radioisotope-guided resection has good acceptance in the scientific community for its fast surgical procedure directed to the lesion; however, the percutaneous technique that stands out is radiofrequency ablation. In the present study, all of the patients submitted to the technique presented total improvement of the pain.

Keywords

► osteoma, osteoid/
diagnostic imaging
► osteoma, osteoid/
surgery
► bone neoplasms/
diagnostic imaging
► bone neoplasms/
surgery
► pain

Resumo

O osteoma osteóide é uma neoplasia benigna comum em homens jovens; porém, pode atingir qualquer idade, acomete preferencialmente ossos longos, e é caracterizada por dor contínua e limitante que é aliviada por salicilatos. É uma lesão de tamanho pequeno, composta por tecido osteóide imaturo, hipervascularização central e área esclerótica circundante. O diagnóstico é realizado pela clínica e auxiliado por exames de imagem, como radiografia comum e tomografia computadorizada. A radiografia, apresenta-se como uma lesão radiolucente central e esclerose periférica. A biópsia está indicada somente nos casos de dúvida diagnóstica. O tratamento cirúrgico envolve a ressecção do nicho, proporcionando maior alívio sintomático, assim como as técnicas percutâneas. A técnica de ressecção guiada por radioisótopo tem boa aceitação na comunidade científica por tornar o procedimento cirúrgico mais rápido e dirigido para a lesão, ainda que o padrão ouro de tratamento seja a técnica percutânea de ablação por radiofrequência. É válido ressaltar que, no presente estudo, todos os pacientes submetidos à ressecção cirúrgica apresentaram regressão do quadro álgico.
**Introduction**

Osteoid osteoma is a benign neoplasm that mostly affects young men (up to 4:1). Although usually occurring between the 2nd and 3rd decade of life, it can affect patients at any age.\(^1\) It is a self-limiting disease, with an average duration of 3 years.\(^2\) Originally described by Jaffe\(^3\) in 1935 as a benign tumor with a predilection for the long bones of the lower limbs, osteoid osteoma is surrounded by a niche (also called nidus) and is characterized by immature osteoid tissue, central hypervascularization, an adjacent sclerotic area, and small size, ranging from 1 to 10 mm.\(^4,5\)

Clinically, it presents as perennial pain with greater intensity at night, sometimes relieved by salicylates and nonsteroidal anti-inflammatory drugs (NSAIDs).

Plain radiography (\(\text{► Figure 1}\)) and computed tomography (CT; considered the gold standard) (\(\text{► Figure 2}\)) are used as diagnostic adjuncts.\(^1,6\) Bone scintigraphy with 99-technetium flow (\(\text{► Figure 3}\)) has a 100% sensitivity in the diagnosis of osteoid osteoma; in addition, it is the test that detects the tumor with most precision, since the large increase in radiopharmaceutical uptake makes biopsy rarely necessary.

Being extremely sensitive, scintigraphy confirms the diagnosis and reduces the delay in its establishment, especially in early-stage lesions, since it shows changes before radiographies. The main differential diagnoses for osteoid osteoma are chondroblastoma, bone infarction and chronic osteomyelitis.

Macroscopically, the niche can be identified as a well-defined, violet-tinted lesion, usually surrounded by a sclerotic halo. Microscopically, it is composed of fibrovascular tissue with immature bone trabecula which are delimited by prominent halo-shaped osteoblasts.

Surgical treatment provides rapid symptomatic relief, with a high success rate ranging from 88 to 100%; in addition, it is associated with few relapses, and it allows both histological examination and surgical removal of the entire niche. Several techniques have been developed, including en bloc resection of osteoid osteoma and adjacent bone and niche curettage to remove part of the surrounding reactive bone. The main challenge, however, is the exact location of the niche.\(^7-9\) Gamma probe-guided surgical en bloc resection may solve this issue, reducing the size of the incision, increasing the likelihood of removing the entire niche and allowing diagnostic confirmation by pathological examination.\(^6\)

The gamma probe-guided resection method is performed in two stages; the first stage is performed at a nuclear medicine center, in which the patient is submitted to a technetium bone scintigraphy with subsequent demarcation of the affected topography according to the images obtained. The second stage takes place in the operating room, using a gamma ray probe as a scanning tool.\(^10\)

Nowadays, however, radiofrequency ablation is considered the most accepted method for percutaneous destruction of the niche, mainly because of its significant advantages over other techniques. Radiofrequency ablation is a fast, safe and effective technique, suitable for most patients, and it can be performed in most centers.\(^11,12\)

The present study aims to describe the gamma probe-guided bone tumor resection technique and to evaluate the postoperative pain improvement.

**Materials and Methods**

This is a prospective study conducted in 14 osteoid osteoma patients who underwent gamma probe-guided resection in an accredited hospital between May 2010 and May 2017. Medical records, pre- and postoperative pain analogue scale scores and patient satisfaction were analyzed. In total, 11 (78.47%) patients were male and 3 (21.43%) were female, with ages ranging from 3 to 41 years old (\(\text{► Table 1}\)).

Due to the character of the study, an Informed Consent Form and a data sheet with relevant aspects, such as date of surgery, topography, pre- and postoperative analogue pain scale and the technique used, were provided.

Patients submitted to another surgical technique were excluded from the present study.
The patients underwent surgery under general anesthesia or regional block in the operating room.

On the day of surgery, patients underwent the first stage of treatment at the nuclear medicine center, where a technetium-99 bone scintigraphy following an injection of 1,110 MBq of MDP-99mTc in adults; for children, this dose was corrected according to age and body weight. Images were obtained ~ 2 hours after the injection of the radioisotope. Aided by technetium-99 flow scintigraphy (►Figure 4), the sites of highest uptake by the gamma ray probe were marked on the skin (►Figures 5A and 5B) to assist in the incision at the operating room. After demarcation, the patient was referred to the operating room, where the second stage of treatment was performed. Patients were anesthetized with the appropriate technique for each case and tumor resection began. The incision was based on preoperative examinations and markings resulting from reading the niche-emitted radiation. After surgical access and location of the supposed lesion site, the probe was positioned in a 90° angle to the bone surface to identify the niche, which was the point of highest radiation emission. After determining the point of greatest uptake, an en bloc resection was performed.

After collecting the material required for anatomopathological analysis, about 1 to 2 mm of the cavity was enlarged and submitted to a curettage, followed by cleaning with 0.9% saline solution (►Figure 5). Next, the gamma probe was used in the resected area to confirm a decrease in uptake. Tissues were sutured in planes. Bone grafting was performed as required by the surgical site.

Postoperatively, after anesthetic recovery, the procedural success could be assessed by its correlation with pain relief.
A total relief in the pain reported prior to the surgery indicates that the niche resection was complete.

**Results**

In total, 11 (78.47%) patients were male and 3 (21.43%) were female. All 14 (100%) patients underwent a gamma probe-guided resection. All of the patients reported complete symptomatic relief (100%) (Table 2). Eleven (78.47%) lesions were located in the lower limbs, and 3 (21.43%) were found in the upper limbs (Table 3). The most affected bone was the tibia (n = 6; 42.85%), followed by the femur (n = 4; 28.57%); other bones were affected less frequently (Table 4).

The most affected age group was the 3rd decade of life (n = 5; 35.7%), followed by the 2nd and 4th decades, which were similarly affected (n = 3; 21.4%), the 1st decade (n = 2; 14.3%) and, finally, the 5th decade of life (n = 1; 7.2%).

The prevalence of osteoid osteoma peaked at the 2nd decade of life, which ranges from 21 to 30 years old. Patients between 0 and 10 years old consisted ~15% of our casuistry; both the age groups ranging from 11 to 20 years old and from 31 to 40 years old comprised 20% of the sample, and the last age group, from 41 to 50 years-old, accounts for ~5% of the sample (Figure 6).

**Discussion**

Osteoid osteoma is described in the literature as a frequent benign tumor lesion that affects mainly young men, being

---

**Table 2** Pain assessment in the evaluated patients and respective percentual values

|                | Total Relief | Partial Relief | No Change |
|----------------|--------------|----------------|-----------|
| Total (n = 14) | n = 14       | 0              | 0         |
| Percentage (%) | 100%         | 0%             | 0%        |

**Table 3** Segmental distribution in affected patients and respective percentual values

|                | Lower Limb | Upper Limb |
|----------------|------------|------------|
| Total (n = 14) | n = 11     | n = 3      |
| Percentage (%) | 78.47%     | 21.43%     |

**Table 4** Distribution of affected bones and respective percentual values

| Affected Segment | Total (n = 14) | Percentage (%) |
|------------------|----------------|----------------|
| Humerus          | n = 1          | 7.14%          |
| Tibia            | n = 6          | 42.85%         |
| Fibula           | n = 1          | 7.14%          |
| Femur            | n = 4          | 28.57%         |
| Scapula          | n = 2          | 14.3%          |
Radioisotope-guided resection is a safe technique. It can be performed in any facility with a nuclear medicine center, and it reduces the number of procedures for the patient and the size of the incision (which was not evaluated in the present work, but may be assessed in the future). In addition, guidance to the incision site is more reliable, and intraoperative tumor niche location is more accurate. Although the diagnosis can be confirmed through a pathological examination, Sim et al.22 state that negative results do not exclude the correct diagnosis, since the niche material is friable and it can often be poorly selected at the time of collection due to its small size.

Since the cause of severe pain is the presence of the niche, this technique is considered successful because the postoperative pain relief rate was 100%. Other confirmed literature parameters were the prevalence of long bones and involvement of the lower limbs.4

Conclusion

Radioisotope-guided resection is a safe and definite technique, although it is not the current gold standard. It is considered an appropriate option for osteoid osteoma treatment with 100% immediate postoperative pain relief.

Although there are disadvantages of surgical resection in relation to minimally invasive techniques, such as a larger surgical incision and the need for a close relationship with nuclear medicine, especially regarding scintigraphy, it is essential to emphasize that advantages, such as cost reduction, scintigraphic accuracy and specimen collection for anatomopathological analysis, make this technique an excellent choice. In addition to the characteristics mentioned above, it is believed that technical precision allows for a shorter surgical time, which may be assessed in further studies.

Conflict of Interests

The authors have no conflict of interests to declare.

References

1 Canale ST, Beaty JH. Campbell cirurgia ortopédica. 12ed. Rio de Janeiro: Elsevier; 2017
2 Jesus-Garcia R. Diagnóstico e tratamento de tumores ósseos. Rio de Janeiro: Elsevier; 2013
3 Jaffe HL. Osteoid osteoma. A benign osteoelastic tumor composed of osteoid and atypical bone. Arch Surg 1935;31(05):709–728
4 Sousa M, Freitas D, Cardoso P. Osteoma Osteóide? Rev Port Ortop Traumatol 2014;22(01):135–141
5 Lee EH, Shaﬁ M, Hui JH. Osteoid osteoma: a current review. J Pediatr Orthop 2006;26(05):695–700
6 Endo RR, Gama NF, Nakagawa SA, Tyng CJ, Chung WT, Pinto FFE. Osteoid osteoma - radiofrequency ablation treatment guided by computed tomography: a case series. Rev Bras Ortop 2017;52 (03):337–343
7 Rankine JJ. The diagnosis and percutaneous treatment of osteoid osteomas. Curr Orthop 2007;21(06):464–470
8 Papathanassiou ZG, Megas P, Petsas T, Papachristou DJ, Niñas J, Siablis D. Osteoid osteoma: diagnosis and treatment. Orthopedics 2008;31(11):1118
9 Nielsen GP, Rosenberg AE. Bone-forming tumors. In: Folpe AL, Inwards CY. Bone and Soft Tissue Pathology: a volume in the
series foundations in diagnostic pathology. Philadelphia: Churchill Livingstone; 2010:309–328

10 Etchebehere M, Etchebehere EC, Reganin LA, Amstalden EM, Ciquet A Jr, Camargo EE. Intraoperative localization of an osteoid-osteoma using a gamma probe. Int Orthop 2004;28(06):379–383

11 Vigorita VJ. Orthopaedic pathology. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 2008:339–348

12 Campanacci M, Ruggieri P, Gasbarrini A, Ferraro A, Campanacci L. Osteoid osteoma. Direct visual identification and intralesional excision of the nidus with minimal removal of bone. J Bone Joint Surg Br 1999;81(05):814–820

13 David A, Rios AR, Tarragô RP, Oliveira GK, Garzela MM, Oliveira RK. Excisão de osteoma osteóide por tração orientada pela tomografia computadorizada. Rev Bras Ortop 1997;32(05):396–400

14 Ehara S, Rosenthal DI, Aoki J, Fukuda K, Sugimoto H, Mizutani H, et al. Peritumoral edema in osteoid osteoma on magnetic resonance imaging. Skeletal Radiol 1999;28(05):265–270

15 Gangi A, Dietemann JL, Gasser B, Mortazavi R, Brunner P, Mourou MY, et al. Interstitial laser photoacoagulation of osteoid osteomas with use of CT guidance. Radiology 1997;203(03):843–848

16 Lindner NJ, Ozaki T, Roedl R, Gosheger G, Winkelmann W, Wörtler K. Percutaneous radiofrequency ablation in osteoid osteoma. J Bone Joint Surg Br 2001;83(03):391–396

17 Sluga M, Windhager R, Pfeiffer M, Dominkus M, Kotz R. Peripheral osteoid osteoma. Is there still a place for traditional surgery? J Bone Joint Surg Br 2002;84(02):249–251

18 Yang WT, Chen WM, Wang NH, Chen TH. Surgical treatment for osteoid osteoma – experience in both conventional open excision and CT-guided mini-incision surgery. J Chin Med Assoc 2007;70(12):545–550

19 Moser T, Buy X, Goyault G, Tok C, Irani F, Gangi A. Image-guided ablation of bone tumors: review of current techniques. J Radiol 2008;89(04):461–471

20 Yildiz Y, Bayrakci K, Altay M, Saglik Y. Osteoid osteoma: the results of surgical treatment. Int Orthop 2001;25(02):119–122

21 Parlier-Cuau C, Champsaur P, Nizard R, Hamze B, Laredo JD. Percutaneous removal of osteoid osteoma. Radiol Clin North Am 1998;36(03):559–566

22 Sim FH, Dahlin CD, Beabout JW. Osteoid-osteoma: diagnostic problems. J Bone Joint Surg Am 1975;57(02):154–159