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Vertebroplasty in the treatment of vertebral metastases: clinical cases and review of the literature

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Abstract. – **Bone metastases are the most common tumours affecting the musculoskeletal system. The most frequently affected area of the skeleton is the spine. The vertebral bodies are reached largely via the bloodstream and neoplastic substitution of the bone tissue causes progressive structural destruction leading to loss of stability and compression of the intracanal nerve structures.**

The treatment of bone metastases in the spine is different and controversial, mostly because of the wide spectrum of clinical and radiographic pattern of the local and systemic disease.

Percutaneous vertebroplasty is emerging as one of the most promising new interventional procedures for relieving (or reducing) pain and improve stability.

In this article we review indications, contraindications, technique, and complications of percutaneous vertebroplasty in spine metastases.

Key Words:

Vertebroplasty, Metastases, Complications.

Introduction

The incidence of bone metastases during the clinical course of carcinoma lies second after pulmonary and liver localization[1]. The vertebral column is the most commonly affected site: is estimated that more than 10% of neoplastic patients develops a symptomatic spine metastases[2,3]. The progress of oncology in the last few years, have consistently improved the life expectancy and the of the quality of life of most carcinomas. Conversely, the role of vertebral metastases in worsening of quality of life is more and more emphasized, but the treatment is still controversial[4].

Vertebroplasty (VP) is a mini-invasive technique consisting of percutaneous injection of Polymethilmetacrilate (PMMA) into the vertebral body either under fluoroscopic or TC guidance. It may be performed either under general anesthesia, or local anesthesia.

The first case of VP reported in literature was performed by Deramond in France in 1984 for the treatment of an aggressive hemangioma of C2[5]. Since that time until today VP spreaded out considerably its indications: spine metastases, plasmacytoma, osteoporotic collapse and traumatic fractures[6-8].

Our purpose is to critically review the literature to identify indications and limit of VP in the treatment of tumor of the spine.

Literature Review

According to the data reported from Galibert et al in 1987[5], VP was first employed in osteoporotic vertebral collapses, in metastatic vertebral fractures, plasmacytoma, hemangiomas. Later on, VP was used in the treatment of traumatic compression vertebral fractures type A1 (integrity of posterior wall)[9].

From an analysis of the literature it could be found a pour homogeneous pathogenetic series of cases[10] (Table I).

The first consideration coming from the analysis of previous data is the shortness of follow-up. Furthermore poor accent is given on the percent-

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Table I. Literature review.

Author	N° pts/treated levels	Results	Complications
Deramond (1998)[11]	101 pts	Pain control: 80% very good pain relief	
Weill (1996)[12]	37 pts /52 VP 3 pts: laminectomy and posterior arthrodesis 2 pts: surgery and RT	F.U.: 7.1 months Pain control: 73% good pain relief 21% moderate pain relief 6% no modifications	2 pts (5%) death caused by pulmonitis ed pulmonary embolism 3 pts (8%) transient radiculopathie caused by cement leakage 2 pts (5%) transient dysphagia
Cortet (1997)[13]	37 pts /40VP 29 metastases + 8 plasmacytoma	F.U.: 4,2 months Pain control: 13,5% complete relief 54% very good pain relief 30% moderate pain relief 2,5% no modifications	2 pts (5%) severe radiculopathie caused by cement leakage into the neuro foramen and solved by surgical approach
Kaemmerlen (1989)[14]	20 pts /33VP all the pts treated else by RT	F.U.: 2,8 months Pain control: 70% very good pain relief 15% good pain relief 10% no modifications 5% spinal cord compression	1 pt (5%) compressive myelopathie
Gangi (1999)[15]	187 pts /289VP 69 pts metastases or plasmacytoma	F.U.: 7 months Pain control: 85% very good or good pain relief results on 69 oncological pts	3 pts (1,6%) thoracic radiculopathie caused by cement leakage near the neuro-vascular intercostal cord, treated with cortisonic infiltration On the whole series of pts

age of local recurrence of the neoplasm and more on the global progression of the tumoral disease[11-14].

An anti-tumoral effect, by cytolitic activity of PMMA, is thought to play a significative affect the local control of disease[12].

We believe that low incidence of local recurrence is not a consequence of tumoral cytolysis caused by PMMA, rather a consequence of short survival of those patients.

The main indication of VP in metastatic patients is to achieve local pain control[15]. Many authors agree with the opinion that a good result may be a 50% pain reduction.

In many reviewed articles we were not to find important data like Karnofsky Performance Status (KPS), pre-operative ASA-score, histology, the presence of further bone or visceral metastases. All these parameters are too frequently not reported by most of the authors. To have a comprehensive view of this kind of patients, it would be of great importance to report something more about survival time, neurological status, and more about the cause of the death and the healthy and ambulatory status at that time.

Many authors, in order to reach a satisfying local control of the disease and to reduce the risk of cement migration into the epidural vein, proposed a combined use of radiofrequency termoablation and VP[16,17]. Partial destruction of the tumoral mass and thrombosis of intra- and paravertebral vessels are the aims of such a therapeutic strategy.

Moreover the partial empting of the cavity from neoplastic tissue in metastatic lesions by means of radiofrequency or laser, prevents the risk of hyper-pressurization inside the vertebral

body during cement injection, reducing risk of embolism, and creates a place around the lesion that allows to form a coating by PMMA (reducing risk of mass expansion and vascular diffusion of neoplasm)[18].

No mentions in literature are about the histological changes within tumoral tissue after radiofrequency, but the effectiveness of such a method is based on good results in terms of pain control and low percentage of local recurrence of disease[19,20].

The worst complication of this technique is thermic cytolysis of nervous tissue. A study of Dupuy et al[21] reports as relatively safe to use radiofrequency only in those cases in which an integrity of posterior vertebral wall is demonstrate. The presence of cortical bone intact acts like insulating barrier. Many authors believe enough the presence of spinal fluid between tumoral mass and spinal cord to prevent thermical damages.

Others authors purpose an algorithm for treatment of vertebral fractures[22] in cancer patients by means of VP and Kyphoplasty as an alternative to radiotherapy and open surgery. Indication to VP or Kyphoplasty is given in those patients with persistent pain, neither responsive to the common pain–killer nor to bed rest, free from neurological complications.

KP is preferred to VP when the posterior vertebral wall is not intact and more when the kyphosis angle is more than 20°. No local complication (cement leakage) was found in the KP group compared to 9,2 % of the VP group, whereas in terms of pain reduction no significative differences were found between the two groups. Is important to underline that no patient had a histological diagnosis of the lesion and no distinction was made between vertebral fractures in plasmacytoma or in metastases.

Reidy et al. studied the pressure generated into metastatic and normal vertebral bodies during the injection of PMMA. The pressure was 8 fold graters in the metastatic group, causing in one case the leakage of the tumor into the epidural space. This pressure augmentation should be justified by the hydraulic permeability difference between tumor tissue and bone marrow; low porosity of cancer tissue opposes the fluid distribution of PMMA into the vertebral body[23]. As in the nailing of the long bones, during the VP the pressure augmentation cause formation and diffusion in the circulation of microthromboses of fat and lung microembolism[24-26]. Basing on this it is possible suppose that during the VP of a metastatic vertebral body also the cancer tissue could cause embolism in the lung, disseminating the disease and worsening the patient prognosis.

Complications

Neurological, infective, pulmonary and cardiovascular complications can occur related to VP.

Cement-embolism is a particular kind of micro-embolism typical of VP. Padovani et al reported on a 41 years old patient affected by low-back pain in vertebral histiocytosis. Suddenly after VP typical embolic symptoms appeared. Later on X-ray showed a pulmonary infarct caused by a cement-microembolism into the pulmonary artery[27].

Further authors described later the same complication[28-32]. Scroop et al[33] described a similar case in which a cement-embolism into the cerebral artery, through Botallus foramen's patency, secondary cerebral ischemia and hemiplegia led to death. A lot of symptom less cerebral microembolism and symptomatic pulmonary embolism were found in the same patient.

Septic complications after VP are very rarely reported in literature. Yu et al described a spondylitis following a VP in a 78 years old woman with osteoporotic collapse[34].

Several authors report a higher rate of complications in metastatic patients, compared to osteoporotic, traumatic and oncologic (plasmacytoma or hemangioma) patients. Pilitis attributes a complications rate of 10%, 2-5% and 1-3% respectively in metastases, hemangioma and osteoporotic collapse patients[35].

The most frequently described complication is asymptomatic cement leakage, ranging 2% to 73% per treated level, depending on different groups of patients[16]. A risk factor for such a complication is represented, in metastatic vertebrae, by bone defect of the posterior vertebral wall or peduncolar lysis.

Bone defect within posterior wall is considered as relative contraindication. On the opposite, coagulation diseases, local or systemic sepsis, symptomatic spinal cord compression and cardio-respiratory diseases are considered as absolute contraindications[16].

Conclusions

In agreement with several authors we consider skeletal metastases and particularly spine metastases as an expression of systemic disease and consequently we stress the concept about the need of a multidisciplinary approach. Radiotherapy, chemotherapy and surgery integrate one each other towards a better local control of the disease[4,36-38].

The improvement of anesthesiological techniques allows today to perform surgical procedures, once thought as prohibitive, making possible, in most of cases, to restore or maintain movement, sensitivity, dignity and hope, as well as pain control, in order to reduce the need of analgesic drugs.

The criteria for a decision making process must consider: life expectancy, function reaction, pain control and local control of disease.

The option to perform VP in local anesthesia make possible his employment also in those patients who are in bad health conditions (ASA 4), for whom endo-tracheal intubations were too dangerous. In such patients affected by plurimetastatic disease with short life expectancy, VP may be helpful in pain control and improvement the quality of life. We treated a young lady affected by a disseminated breast cancer with a L3 pathological fracture; radiotherapy removed cancer tissue by the vertebral body, but the patient complained low back pain due to the mechanical insufficiency. VP resolved both the mechanical and pain problems (Figure 1).

In our opinion the biopsy before VP is determinant suspecting oncologic diseases; differential diagnosis between primary and secondary tumors of the spine could be difficult basing only on the clinical and imaging data. M.G. a 38 years old man presented to us complaining of chronic low back pain and walking difficulties after a L2 vertebroplasty performed elsewhere 14 months before for a suspected haemangioma, diagnosed just on imaging examinations, without biopsy. The patient underwent a decompression and osteosynthesis. The histological diagnosis was aggressive plasmacytoma, so the patient followed the chemotherapy protocol with the remission of the pathology (Figure 2).

Although VP itself for treatment of vertebral metastases gives low peri- and post-surgery morbidity and good pain control, on the opposite does not allow good local control of disease and more, may cause pulmonary dissemination of tumoral cells.

The best situation to perform a VP is when the vertebral body is completely emptied of tumor by chemotherapy or radiotherapy; so we are facing such a secondary osteoporosis causing pain and mechanical insufficiency of the vertebral body. P.R. a 54 years old male presented to us with multiple vertebral collapses after chemotherapy for a multiple myeloma. He complains of chronic low back pain and he could not walk without two sticks. TC and MRI showed the absence of myeloma into the vertebral bodies, which were completely empties; it was a secondary osteoporosis due to chemotherapy. The patient underwent vertebroplasty of T12, L1, L2, L3 e L4 in two sessions with the resolutions of pain functional impairment; after one year he can walk without sticks (Figure 3).

It is important to determine when to do and when not to do a VP. There are situation, as in a primary spine tumor, when VP is absolutely not indicated as isolated procedure. Also in secondary disease of the spine, severe osteoporosis and segmentary kyphosis could represent contraindications of VP. G.A. a 52 years old lady presented to our emergency room complaining heavy pain at thoracolumbar junction. X-ray showed T11 collapse, but blood tests demonstrated a myeloid chronic leukaemia, confirmed by a bone marrow biopsy. She underwent chemotherapy with remission of the systemic disease, but she could not stand up and walk for the back pain. New X-rays and MRI showed a worsening of the T11 collapse and a 25° segmentary kyphosis, associated to a L5-S1 spondilolisthesis. DEXA demonstrated spine severe osteoporosis. In our opinion VP was not able to stabilize this lesion and to control the back pain, a posterior stabilisation exposed to the risk of screws pull-out for the osteoporosis, so we decide to perform an anterior fusion instrumented with a titanium mesh and a plate. The patient had a perfect recovery (Figure 4).

Association with radiofrequency seems to be a good way to resolve such problems, but is necessary to wait a better scientific support to this theory.

In conclusion VP may be a good option in the treatment of painful spine metastases. The role and the indication of this procedure are still under discussion. In our spine metastases treatment algorithm it is considered only as a palliative indication to control pain due to mechanical insufficiency of the spine vertebral bodies[39] (Figure 5).

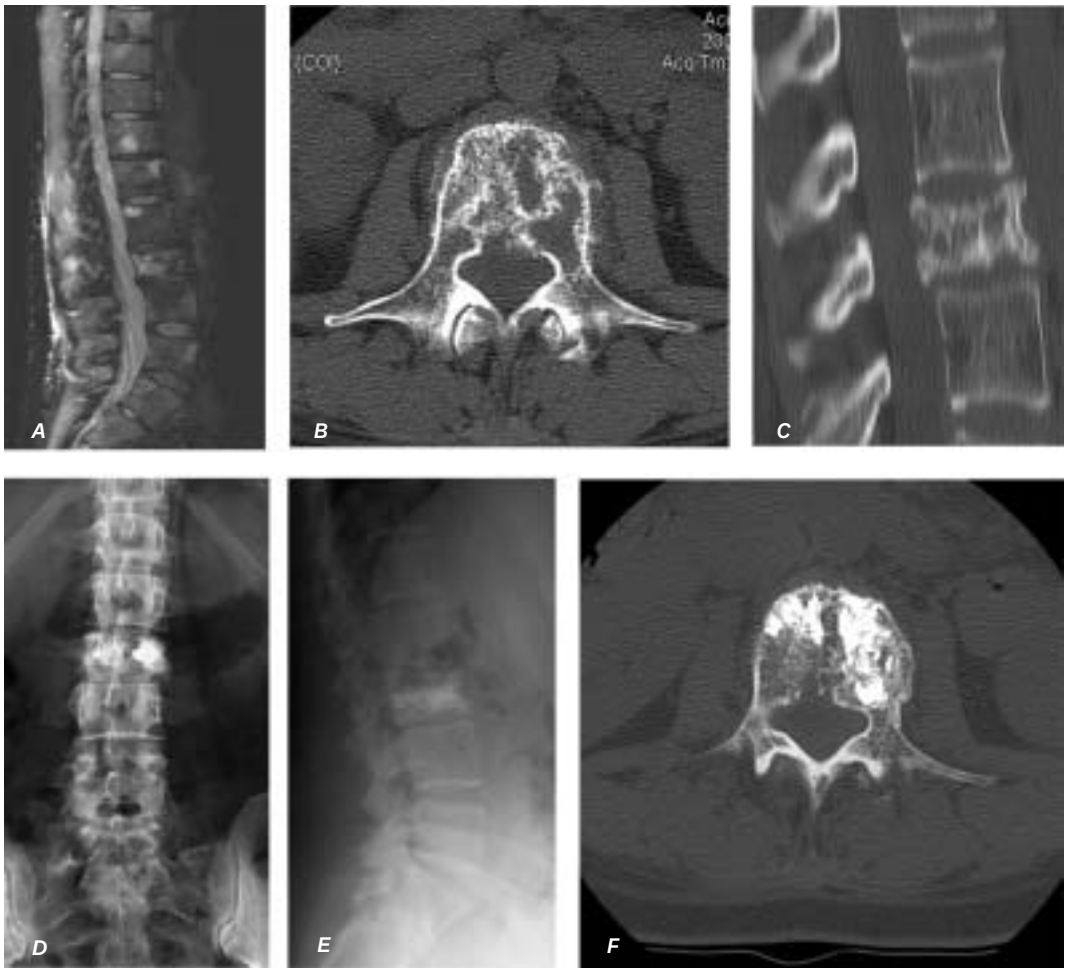

Figure 1. Vertebroplasty in a patient affected by multiple metastases. R.G. a 39 years old female affected by multiple metastases from breast cancer (***A***), presented to us with a L3 pathological fracture (***B, C***). Since 6 months she complained of a severe back pain that forced her to bed rest and to use many analgesic drugs and a brace all day long. The patient underwent chemotherapy and radiotherapy cycles, so the oncologist said to us the impossibility to repeat these approaches. The patient prognosis quod vitam was about 10-12 months. We decided to perform a L3 vertebroplasty (***D, E, F***) associated to a biopsy to confirm the histology. The procedure resolved completely pain and function limitation. The patient removed the brace forever.

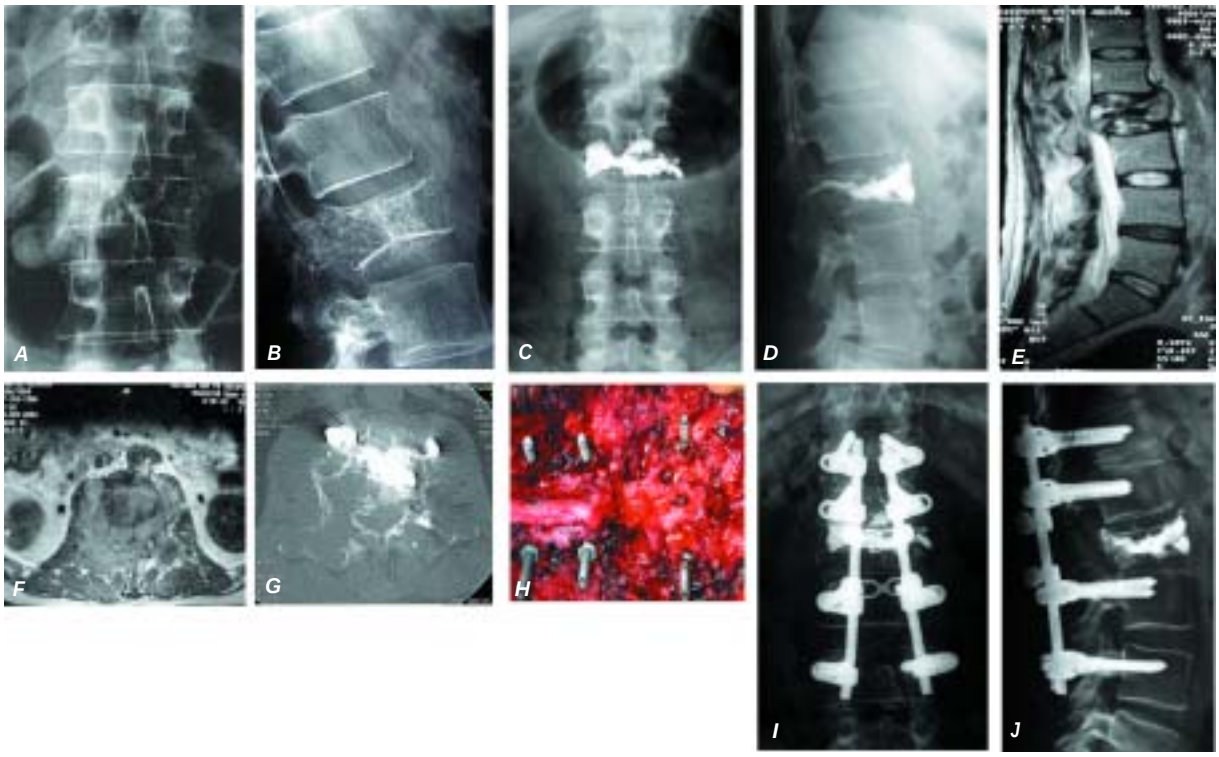

Figure 2. Vertebroplasty outcome in patient treated for uncorrect presumed diagnosis of vertebral hemangioma. M.G. a 38 years old man presented to us complaining of chronic low back pain and walking difficulties after a L2 vertebroplasty performed elsewhere 14 months before for a suspected hemangioma (***A, B, C, D, E, F, G***), diagnosed just on imaging examinations. The patient underwent a decompression and osteosynthesis (***H***). The histologic diagnosis was aggressive plasmacytoma, so the patient followed the chemotherapy protocol with the remission of the pathology (***I, J***).

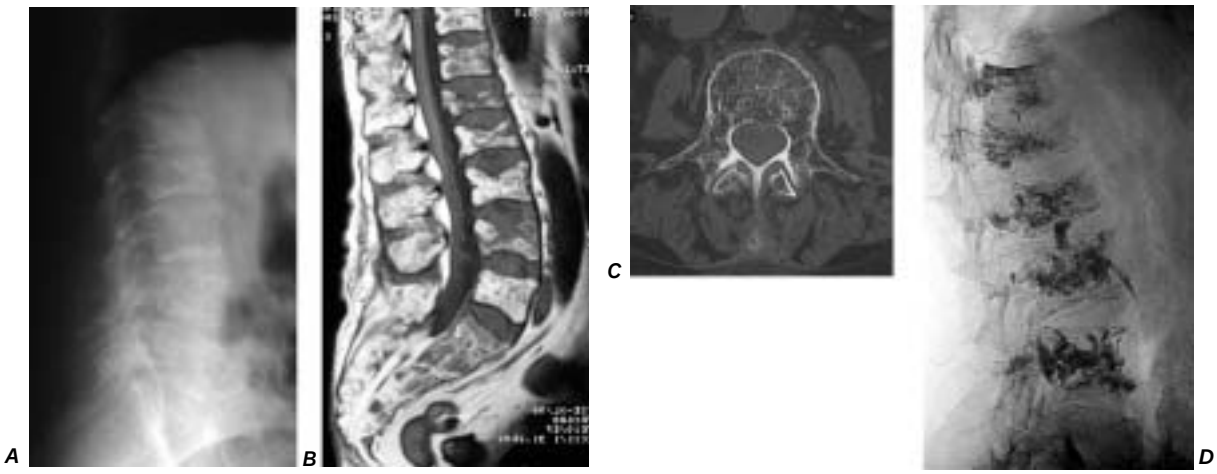

Figure 3. Vertebroplasty in a patient affected by multiple myeloma.P.R. a 54 years old man presented to us with multiple vertebral collapses after chemotherapy for a multiple myeloma (***A, B***). He complain of chronic low back pain and he could not walk without two sticks. TC and MRI showed the absence of myeloma into the vertebral bodies, which were completely empties; it was a secondary osteoporosis due to chemotherapy (***C***). The patient underwent vertebroplasty of T12, L1, L2, L3 e L4 (***D***) in two sessions with the resolutions of pain functional impairment; after one year he can walk without any stick.

Figure 4. T11 collapse in myeloid chronic leukaemia. G.A. a 52 years old lady presented to our emergency room complaining heavy pain at thoracolumbar junction. X-ray showed T11 collapse, but blood tests demonstrated a myeloid chronic leukaemia, confirmed by a bone marrow biopsy. She underwent chemotherapy with remission of the systemic disease, but she could not stand up and walk for the back pain. New X-rays (***A, B***) and MRI (***C***) showed a worsening of the T11 collapse and a 25° segmentary kyphosis, associated to a L5-S1 spondilolisthesis. DEXA demonstrated spine severe osteoporosis. In our opinion VP was not able to stabilize this lesion and to control the back pain, a posterior stabilisation exposed to the risk of screws pull-out for the osteoporosis, so we decide to perform an anterior fusion instrumented with a titanium mesh and a plate (***D, E, F***). The patient had a perfect recovery.

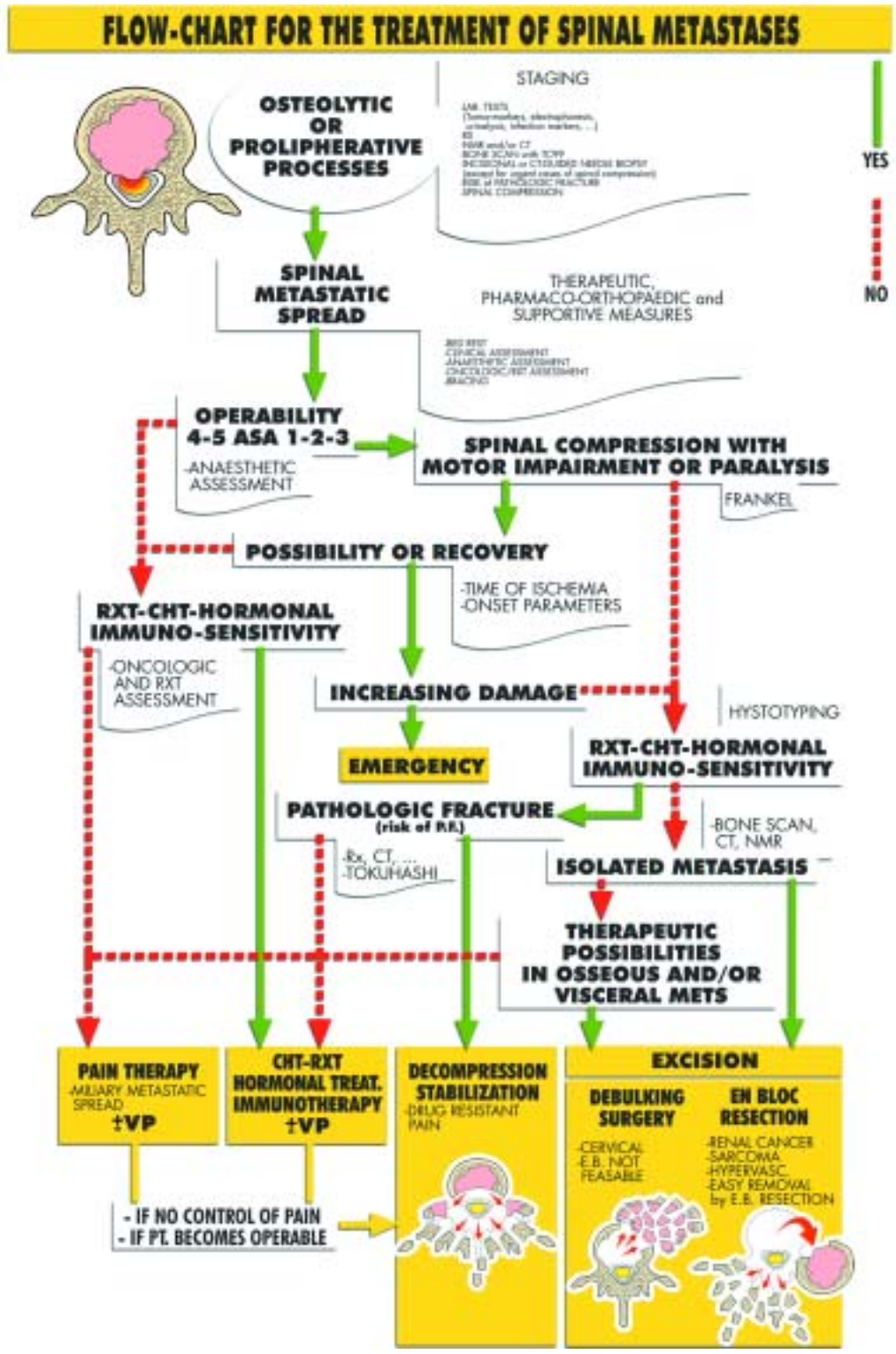

Figure 5. Treatment evaluation algorithm of spinal metastases.

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