

Differential diagnosis of benign tumors and tumor-like lesions in the spine. Own cases and review of the literature

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Although benign tumors and tumor-like lesions of the spine are shown in every orthopedic teaching book, it is often surprising how little attention is paid to the differential diagnosis and diagnostic investigations, respectively, since surgical treatment and postoperative control depends on exact diagnosis. Clinically the importance of this fact can not be over-emphasized. The most common complaint is pain, either local or radicular in nature. Bone deviations are diagnosed radiologically.

Different types of benign bone tumors and tumor-like lesions of the spine including osteochondroma, osteoblastoma, osteoid osteoma, aneurysmal bone cyst, eosinophilic granuloma, hemangioma, and giant cell tumor, their appearance relation to the age and location in the spine were reviewed and the common histologic subtypes described.

Clinical, laboratory and histopathologic findings, radiologic inclusive MRT and scintigraphic features are evaluated. Diagnostic investigations including the invasive techniques of CT guided needle biopsy, Yamshidi needle biopsy and costotransversectomy for biopsy are shown. Treatment including radiation, chemotherapy and the surgical procedure as well as the postoperative treatment of patients with benign tumors and tumor-like lesions of the spine are discussed.

Key words: benign tumors, tumor-like lesions, spine

Primary benign tumors and tumor-like lesions of the spine and sacrum account for 20% to 40% of all tumors diagnosed in the skeletal system. Nevertheless, the wide variety of benign lesions arising in the spine can pose diagnostic and therapeutic challenge for the physician. Benign bone tumors in the spine show, like in other regions of the body, typical locations and age distribution [31]. Meanwhile the locations remained, the age distribution skewed towards earlier decades. Following the literature incidences from 35% to 80% are reported in the first two decades of life, benign sacral lesions occur later. They are encountered between the third and fifth decade. Sacral tumors in children are more likely to be malignant [20].

The common histologic diagnosis for the osseous lesions are osteochondroma, osteoid osteoma and osteoblastoma. Purely chondrous lesions are rare entities. Aneurysmal bone cysts, hemangiomas [4], giant cell tumors, eosinophilic

granulomas are considered to be other significant diagnostic entities [30].

Diagnosis

Radiologic findings. Benign tumors and tumor-like lesions in the spine in most cases show characteristic radiographic appearance, therefore plain radiographs in two planes in a standing position are requested following physical examination [18]. Aneurysmatic bone cyst and giant cell tumor are found to be lytic and expansive, a sclerotic lesion in the pedicle may lead to the diagnosis of an osteoblastoma or osteoid osteoma. Eosinophilic granuloma may cause vertebra plana [57], hemangioma shows coarsened vertical trabeculae [28]. Unfortunately these typical findings are reported in only about 40% of cases. 60% of patients show

nonspecific abnormalities, in a high percentage radiographic studies are interpreted false negatively especially in cases of osteoid osteoma and osteoblastoma [40].

Scintigraphic findings. A scintigraphic bone scan is a helpful investigation in order to reveal a lesion with otherwise normal radiographs. It is non specific but highly sensitive and enables visualization of the entire skeleton. Therefore every change of the mineral uptake comes to view, and the period before diagnosis could be diminished significantly. In plasmacytoma and metastases of hypernephroma false negative technetium bone scans are reported, hemangioma may impress as a cold lesion [52]. This is but not the case for osteoid osteoma or osteoblastoma where additional tissue around the bone can bring interpretation problems.

Magnetic resonance tomography (MRT), computed tomography (CT). MRT is a reliable approach in diagnosis of benign bone tumors and tumor-like lesions in the spine [12]. It is also high sensitive in revealing a process in the bone marrow whereas the specificity is lower, compressive fracture with bone marrow changes may simulate tumor. MRT shows the extent and nature of the tumor, in addition it has a high soft tissue resolution giving even an information of the extrasosseous extend. More recently MRT has become standard in spine lesions diagnostics. Diffusion weighted MR imaging of bone marrow enables differentiation of benign versus pathologic compression fractures. A disadvantage of MRT is the so called flare phenomena which was found when studying osteoblastoma, osteoid osteoma and eosinophilic granuloma: the inflammatory response of the surrounding soft tissue simulates a more aggressive tumor than actually existing [5]. Because of the high exposure of radiation, MRT has suppressed the importance of computed tomography (CT) with its high resolution in bone details, earlier recommended as study of choice to define these lesions.

Biopsy techniques. In case of doubt of the diagnosis biopsy can be indicated. Like in biopsy of tumors in other sites it must be bound to some principles in order to avoid contamination of surrounding tissues. Two major types of biopsy exist: needle and open biopsy. A needle biopsy performed with CT guidance may offer reliable tissue specimen for histological diagnosis, it may be but false negative because the gained volume of tissue is restrained, the localization of the biopsy may be false or the gained tissue may be compressed and unsuitable for histologic evaluation. Biopsy of choice is the Yamshidi needle biopsy yielding tissue sufficient for definitive diagnosis in about 80% of cases. Local anesthesia and mild seduction is requested so that the patient could warn the surgeon in case of nerve root irritation. It is the biopsy of choice in the thoracic as well as in the lumbar spine and sacrum. The procedure includes the puncture of the respective vertebra. In the thoracic spine the entrance for puncture lies about 5 cm lateral to the mid-

line in an angle of about 45°, in the lumbar spine and the sacrum 7–10 cm lateral with an angle of about 30°. To avoid damage of the vessels and if the suspect lesion allows, the puncture should take place from the left side.

Open biopsy should take place in patients where the above mentioned techniques fail. The incision for biopsy must be planned with regard to the definite surgical procedure. In the thoracic spine the costotransversectomy, a posterolateral approach is standard. It was primarily developed for the drainage of tuberculous abscesses. It is less extensive than a formal thoracotomy but offers a poorer exposure. The major advantage is that it does not involve opening of the thoracic cavity. The patient is placed prone on the operating table, with bolsters positioned longitudinally on each side of the rib cage to allow the chest expansion. The incision follows about 8 cm lateral to the appropriate spinous process, the length is about 10 cm. After dissection of the skin and the subcutaneous tissue, cut through the trapezius muscle follows, the erector muscle is shoved off until the transverse process and the posterior aspect of the rib comes to view. The rib is to be resected, the transverse process can also be resected, if greater exposure is necessary. Then biopsy from the vertebral body can take place.

Treatment

Surgical treatment follows the recommendation of Enneking who classified three stages [16]: Stage 1 lesions are usually incidental and require no treatment (hemangioma, osteochondroma), stage 2 lesions are not aggressive but combined with symptoms. If symptoms are unbearable to the patient or danger of a pathologic fracture exists, en bloc resection or curettage is required (aneurysmatic bone cyst, hemangioma, osteochondroma, eosinophilic granuloma, osteoid osteoma). Stage 3 lesions with a local aggressive behavior should be treated performing a wide excision (osteoblastoma [46], giant cell tumor). In stage 3 lesions with neurologic involvement a marginal resection combined with an adjuvant therapy or a wide segmental resection must be discussed with the patient knowing that although an adjuvant therapy took place, recurrences are common (osteoblastoma up to 20%, giant cell tumor 50%). The expected neurologic deficit in case of wide resection must be considered carefully with respect to a local recurrence of the tumor.

After tumor resection short segmental bony fusion to guarantee long term stability mostly in younger patients should take place, acrylic cement should be avoided. In lesions with an uncertain behaviour concerning recurrences in a first surgical step acrylic cement can be insured, which should be changed to cancellous bone from the iliac crest after one year without recurrence.

Because of the incidence of recurrences long-term follow

up is necessary. It is useful to document the postoperative situation (MRT, CT) in order to be able to differentiate between recurrence and postoperative non tumor abnormalities. After bony fusion took place, metal should be removed to decrease metal artifact in radiograms.

Tumors and tumor-like lesions often lead to a scoliosis, initial functional but may become structural. Following surgery scoliosis may be resolved, but sometimes even despite right tumor treatment scoliosis occur or a progress of curves may be observed. The occurrence of scoliosis may correlate with the age of the patients. Therefore all patients should remain under control at least until skeletal maturity.

Radiation in benign tumors and tumor-like lesions in the spine is a discutable approach. In the literature radiation is reported to be effective in hemangioma with a dose from 30 to 40 Gy, in aneurysmatic bone cysts with 30 Gy. A certain response to radiation is also reported in giant cell tumor and eosinophilic granuloma. Because of inherent risks like secondary sarcomatous degeneration with the incidence of fibrosarcoma and osteosarcoma and scoliosis arising in children receiving radiation should be reserved for unresectable lesions.

Chemotherapy is usually indicated in recurrences of eosinophilic granuloma.

Description of different types of benign tumors and tumor-like lesions in the spine

(Clinical course of the patients is shown in Table 1)

Osteochondroma. It is the most common benign lesion in the skeletal system, in the spine only about 15% hold the diagnosis because they are mostly asymptomatic. The relation male to female is 3:1, more then a half of patients are younger then 20 years. The lesion is found in all parts of the vertebral body, symptomatic cases occur in the cervical (60% in C1/C2) and the upper thoracic spine, 5% are found in the sacrum [49, 59]. Neurologic symptoms are common, in 50% a myelopathy is diagnosed, seldom radiculopathy, horner syndrome, cranial nerve palsy and one case of sudden death due to local compression are reported [44]. Growing osteochondroma after skeletal maturity is suspected to be a chondrosarcoma [1, 2, 21].

Table 1

Pat.	Age (yrs)	Sex	Diagnosis	Clinical course	Fig.
1	21	Male	Osteochondroma	Low back pain for several years during activities, after surgical resection pain free.	1, 2
2	9	Female	Aneurysmatic bone cyst	Low back pain under load, after biopsy and fresh frozen section curettage and grafting with bone harvested from the iliac crest. MRT control revealed bony fusion of the defect.	3
3	7	Male	Aneurysmatic bone cyst pedicle of L1	Back pain under load, after biopsy curettage with grafting from iliac crest, MRT control revealed recurrences of the cyst, after re-grafting the cyst showed no recurrences.	4
4	26	Male	Osteoclastoma pedicle of L2	Back pain for 6 months unresponsive to physiotherapy. Radiography revealed destruction of the pedicle of L2. Yamshidi needle biopsy led to the diagnosis of osteoclastoma. Dorso-ventral resection of L2 and restoration of the defect with a titanium cage was carried out. 4 years after surgery no recurrences came to view.	5
5	12	Female	Eosinophilic granuloma body of D4 and D10	Sudden back pain without trauma occurred. The disease was combined with fever and weight loss. MRT of the spine was followed by Yamshidi needle biopsy of D10. A chest tube was applied, paediatric oncologic therapy took place. Pain diminished. In D4 vertebra plana came to view. After 8 months the chest tube was dropped. Further on no recurrences came to view.	6
6	38	Male	Hemangioma of C6	Neck pain for several years. MRT to exclude a disc herniation; incidentally hemangioma came to view, no therapy.	7a, 7b
7	32	Male	Osteoblastoma of D1	Neck pain, no history of trauma. After 3 months plain radiographs and CT scan revealed an expansile-lytic lesion. Open biopsy confirmed diagnosis of osteoblastoma grade I. Surgery included wide excision, two times resurgery because of recurrences was necessary, no iatrogenic neurologic defect occurred.	8
8	26	Female	Osteoid-osteoma of C3	Neck pain responsive to acetyl-salicyl acid. CT and bone scan revealed osteoid- osteoma. Patient remained pain free after resection of the nidus.	9



Figure 1. 21-year-old man with lower back pain. The pedunculated osteochondroma is arising from the spinous process of a lumbar vertebra.

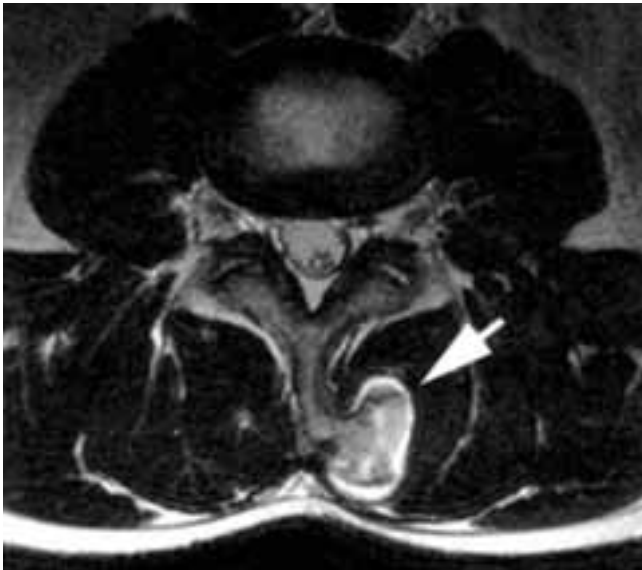


Figure 2. T2-weighted MRI of this solitary osteochondroma. Continuity of the cortical and medullary bone of the tumor with that of spinous process is evident.

Plain radiographs in general is not enough for reliable diagnosis. Only the combination with bone scintigraphy, MRT or CT and the specific age group can define these lesions. A hot scintigraphy in the age group over 30 years is suspicious for sarcoma.

Painful lesions or lesions with a neurologic deficit or growing lesions after skeletal maturity require surgery and a complete local resection including the entire cartilage cap is requested to prevent recurrence (Fig. 1 and 2).

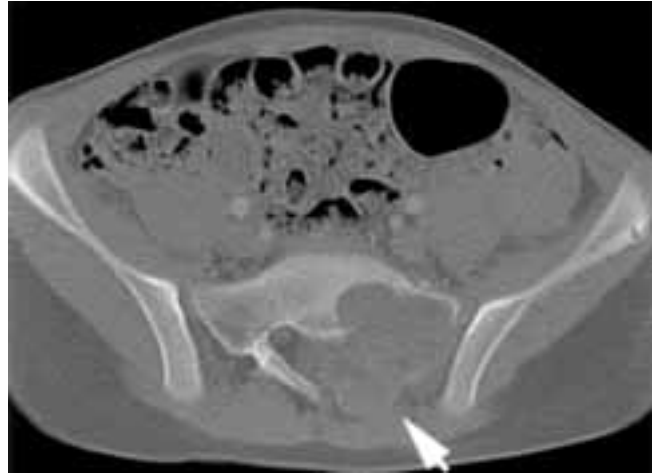


Figure 3. CT scan of an aneurysmal bone cyst (ABC). Expansile, osteolytic lesion of the sacrum. CT confirms the expansile nature of the lesion.

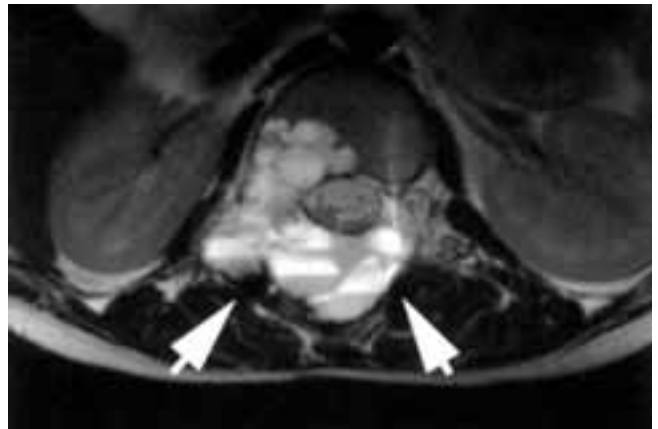


Figure 4. T2-weighted MRI of an spinal aneurysmal bone cyst shows a lesion of high signal intensity with internal septations of low signal intensity. A couple of fluid-fluid-levels are visible.

Aneurysmale bone cyst. With 10% to 20% this is the most common benign lesion in the spine. Most of the patients are below the age of 20 years, no sex is preferred [26, 27]. It is found in the entire spine, and it occurs predominantly in the posterior elements; pathologic fractures are described [50]. In 70% of patients it appears as an expansive lesion with a reactive bone rim, adjacent vertebrae can be involved. Aneurysmal bone cysts can be associated with other tumorous lesions e.g. chondroblastoma and osteoblastoma. Solitary cysts without signs of an expansive lesion are reported.

The most common symptom is back pain, scoliosis and spinal rigidity; acute cord compression and torticollis are also described [11, 15].

Diagnostic investigations include plain radiographs, bone scintigraphy and MRT with gadolinium. MRT shows multiple septations and fluid-fluid-levels within these cysts. This allows the differential diagnosis from other fluid filled

lesions. Arteriography may demonstrate blood filled spaces (Fig. 3 and 4).

Therapy includes angiography and embolisation [22, 35]. Only 50% of patients were cured after this procedure. In case of surgical curettage and intralesional resection following angiography and embolisation a decrease in blood loss is to be expected. Radiation using a dose of 30 Gy is described, but failure in 50% of patients [8, 9, 17]. Because the high failure rate and the inherent risks like secondary sarcomatous degeneration with the incidence of fibrosarcoma, osteosarcoma and scoliosis arising in children receiving radiation this therapy nowadays is not acceptable.

Therapy of choice includes the surgical resection or curettage. Following surgical resection the tumor is usually controlled [56].

Giant cell tumor (osteoclastoma).

About 10% of giant cell tumor occur in the spine, 60% of them in the sacrum. It is dominating in females with a ratio 2:1. The tumor in general is diagnosed after skeletal maturity. Only 10% occur in the age below 19 years. The tumor shows a coincidence with Paget's disease. Local pain is the most common symptom, cases combined with bowel and bladder incontinence to full paraparesis have been reported. Because of the unspecific pain and most processes in the sacrum with an unspectacular plain radiograph the period until diagnosis is between 5–8 months, therefore in unclear cases MRT is requested in early stages to reveal the diagnosis. Scintigraphic bone scan is no help; it can be either hot or cold. Osteoclastoma grade I involves the vertebral body only, grade II and III in form of an expansive, lytic, septated lesion with a cortical breakthrough and a soft tissue mass. Sometimes both, ventral and dorsal aspect of the spine are involved. Concerning the sacral involvement a proximal and eccentric growth is described, whereas Chordoma grows more likely distal and central. Other differential diagnosis must include metastatic tumor, osteoblastoma and aneurysmal bone cyst. Conservative treatment includes radiotherapy [25] and recently biphosphonate therapy was described [19].

Surgery must include a bloc resection, if possible with wide margins because of a high rate of recurrences from 10% to 50%. Like in hemangioma a preoperative angiography with embolisation is useful to decrease the blood loss during surgery. Cryosurgical techniques have been recommended to decrease recurrences. Different behavior of osteoclastoma depending on histopathology (Grade I, II, II) is to be expected, although giant cell tumor grade I shows



Figure 5. 26-year-old man with back pain. Osteoclastoma grade II of the right pedicle L1.

Figure 6. Pathologic fractures of two vertebral bodies due to two eosinophilic granulomas. In T2-weighted images, the signal intensity of involved and flattened vertebral bodies is usually high.

a benign histologic appearance, in higher grade even lung metastases could be detected (Fig. 5).

Eosinophilic granuloma. About 10% of eosinophilic granulomas occur preferably in the thoracic spine, mostly patients are younger than 20 years [7]. It is regarded to be the localized form of the Langhans cell histiocytosis. The tumor presents similar to other benign lesion with pain and stiffness, neurologic deficits have also been reported. Children may suffer from systemic symptoms such as fever and weight loss. Eosinophilic granuloma may present as vertebra plana without disc involvement, or as a lytic process without collapse of the vertebra or posterior element involvement. The tumor may be confused with aggressive lesions because MRT shows extensive high signal areas in T2, bone scan is cold. Differential diagnosis includes metastases, infection, tuberculosis, Ewing's sarcoma, aneurysmal bone cyst, osteoblastoma, neuroblastoma and leukemia. Therefore gaining tissue is important to diagnose the lesion and to begin the definite therapy (Fig. 6).

In the spine aggressive therapy is only requested in cases of neurologic involvement [32] or instability because the lesion shows spontaneous regression including height restoration of the vertebral body with only residual deformity [33]. In these cases curettage and grafting with the help of an instrumentation may be requested, percutaneous vertebroplasty with acrylic cement has also been described [51]. Radiotherapy shows no benefit concerning that lesion but shows the well known side effects.

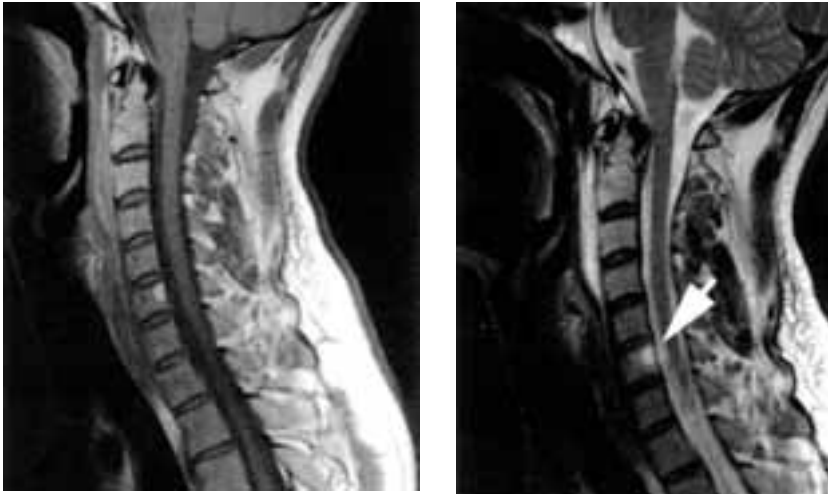


Figure 7. T1- (7a) and T2- (7b) weighted sagittal MR-images of a hemangioma of the cervical vertebra VI. In both weightings, the lesion usually appears with high-signal intensity.

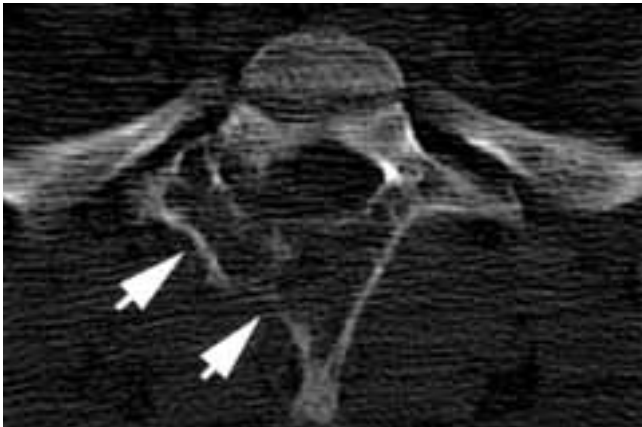


Figure 8. Osteoblastoma of the spine: An expansile – lytic lesion affects the transverse and posterior elements of a thoracic vertebra as depicted in a transversal CT scan.

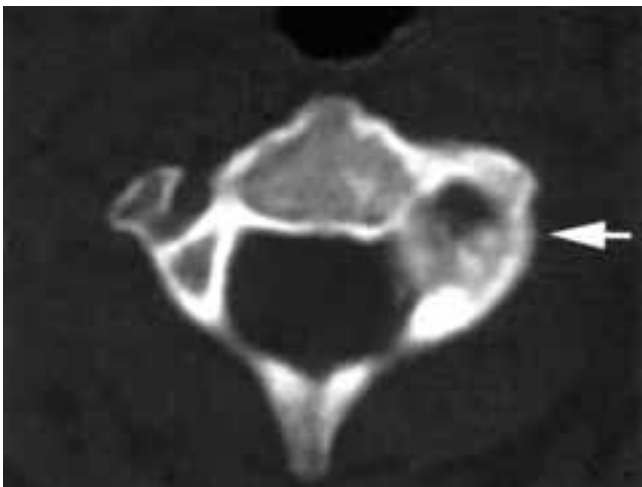


Figure 9. An osteoid-osteoma of the third cervical vertebra is shown by transaxial CT scan. The non calcified nidus is surrounded by sclerotic bone.

Hemangioma. Hemangioma in vertebral bodies is a frequent finding, in most patients without clinical impact. In a large autopsy study in 10% of specimens hemangioma was diagnosed. Because of the multiple vertebral involvement, confusion with aneurysmal bone cyst may occur. Symptomatic hemangioma is found in the 3rd and 4th decade of life and during pregnancy. Pains may be explained by pathologic fracture, hematoma or spreading in the soft tissue. Neurologic involvement is unusual, few cases are described in the thoracic spine with large soft tissue mass and additional vascular malformations.

The lesion is found with a preference of the thoracic spine in the anterior vertebral body, 40% show an involvement of the posterior elements.

The classic presentation of hemangioma on plain radiographs are coarsened vertebral striations representing thickening of the vertical trabeculae of the vertebra. CT scan shows characteristic signs, MRT is connected with high signal images on both T1- and T2-weighted images, bone scan can either be hot or cold [6, 10]. Differential diagnosis includes Paget's disease affecting the whole vertebral body, the cortical bone is found to be more thickened (Fig. 7).

Radiotherapy requests doses from 30 to 40 Gy, either in a single course in 6-8 weeks or in multiple courses. Results are better in the single course group. Radiotherapy includes the risk of sarcomatous degeneration, therefore should not take place in children [36].

Embolisation of the tumor is an accepted method of treatment although it is verified that embolisation alone shows only transient relief of symptoms. The use of permanent occlusive material has shown to be superior compared to temporary occlusion. Vertebroplasty has been described as mode of treatment of pathologic fractures in hemangioma without neurologic symptoms [37, 45].

Surgery should take place in cases of pathologic fractures with neurologic deficit or deformity. Embolisation before surgery is useful to prevent blood loss. Using a ventral approach to the spine, resection of the vertebral body followed by a titanium cage restoration of the defect filled with cancellous bone of the iliac crest is standard.

The treatment of recurrent eosinophilic granuloma is challenging. The goal is to effectively cure the lesion with minimal short-term and long-term side effects. Systemic steroids, vinca alkaloids, antimetabolites, and antifols are preferred because they have less toxicity and mutagenicity. Combination chemotherapy appears to be effective in recurrent disease.

Osteoblastoma. Osteoblastoma, approximately 10% of

primary spine tumors, is the most aggressive of the described lesions in that region. 50% are found in the lumbar spine. All in all about 30% of osteoblastoma occur in the spine [47]. The tumor is found in the second and third decade of life. Males are predominant with 2:1. Histologically assembling osteoid osteoma it shows a different biological behavior. The tumor involves the posterior elements, most commonly the pedicle, an isolated anterior vertebral body involvement is rare [55]. Plain radiographs show an expansive, destructive lesion with a thin rim of intact cortical bone. Bone scan is always hot. MRT is useful in diagnosis, it can also mislead in the T2-weighted images to a not existing soft-tissue extension mass. CT scan shows the exact extend of the tumor and the bone destruction (Fig. 8).

Differential diagnosis include aneurysmal bone cyst, osteomyelitis, osteoid osteoma, eosinophilic granuloma and lymphoma [39]. Once diagnosis is held, surgery is requested. A wide excision is necessary in order to prevent recurrences, found in about 20% of patients with intralesional excision [47]. Recurrences depend also on the histologic grade of the tumor. Following surgery long term follow up evaluation using MRT or CT scan is necessary. It is helpful to proceed a scan postoperative, either MRT or CT in order to be able to discriminate recurrences from postoperative lesions. In this tumor radiotherapy and adjuvant therapy show no effect.

Osteoid osteoma. Histologically very similar to osteoblastoma, osteoid osteoma shows a different biological behaviour [43]. The tumor is found in the second and third decade of life, almost in men. Night pain in the spine occur, a relief to salicylate is reported in only about 30% of patients [48]. Clinically a painful scoliosis without rotation of the vertebral bodies in plain radiographs is found, bone scan is hot [53]. Scoliosis show rigidity and progress, spinal motion is limited [38]. The most common radiographs show a sclerotic lesion in the pedicle, CT scan is necessary to localize the exact location of the nidus [53], injection of radioisotope may be helpful (Fig. 9). During surgery use of a gamma counter or CT-guided thermocoagulation can be helpful [13].

The lesion is not local aggressive, if untreated scoliosis may become structural. Therefore, complete excision of the nidus is the treatment of choice, prompt relief of pain and correction of scoliosis is common after surgery. In 20% of patients scoliosis becomes progressive after surgery. This fact depends on curves preoperatively and duration of scoliosis [34].

Discussion

Benign tumors or tumor-like lesions of spine are very rare and easily misdiagnosed in younger patients with per-

sistent back pain. Patients whose symptoms progress or fail to respond over an appropriate period of time should be further evaluated remembering that benign tumors and tumor-like lesions are the second most common diagnosis following trauma in children and adolescents. Certain tumors have propensities in occurring: Osteoid osteoma and osteochondroma can almost be found in the posterior elements [45], likewise eosinophilic granulomas, giant cell tumors and hemangiomas occur in the anterior aspect of the vertebral body [3, 41, 54]. Mostly patients complain local or radicular pain in the involved area [29]. In unclear etiology of pains in the spine in children benign tumors are the second most common diagnosis following trauma [42]. A frequent but not constant finding is night pain in osteoid osteoma and osteoblastoma. Involving the posterior region of the nerve root also radiating pain mimicking disc herniation can be observed in 30% to 40%, and should cause suspicion in children as an unusual population group [49]. Scoliosis caused by spine tumor may arise due to a bony destruction as well as caused by muscular tension typically without rotation and wedging [23, 24, 46]. In these cases scoliosis show an early upset and a rapid progression, it is considered to show extreme rigidity with a lack of typical compensatory balancing curves above or below the lesion. These factors may help distinguish this type of scoliosis from idiopathic scoliosis occurring at the same age. Reviewing painful scoliosis in adolescents in 50% osteoid osteoma was found in the concave apex of the curve. Torticolis in higher percentage is found as a clinical symptom in osteoid osteoma of the cervical spine. Neurologic deficit is a rare finding and is reported to be about 15% with incidence of a sensory and about 5% with the incidence of focal motor deficit. Compression in the cervical and thoracic spine caused by tumor growth lead to myelopathy, pathologic fracture can cause paralysis.

Evaluation of pain must include plain radiographs in a standing position in order to reveal local destruction or the presence of scoliosis. Additionally MRT with both T1- and T2- weighted images with gadolinium and a 3-phase-bone scintigraphy are necessary.

In most patients with unclear pains in the spine using these investigations diagnosis can be held. In furthermore unclear lesions biopsy is indicated. Different techniques including CT-guided needle or Yamshidi needle biopsies as well as open techniques are described. Biopsies include risks of bleeding, damage of neural structures and infections. For the patient closed techniques with thin needles are more comfortable because they are less painful and show no scars. For the pathologist they are but connected with diagnostic difficulties because of rare and often destroyed tissue. Open biopsies require hospital rest, anesthesia and show scars of surgical intervention, on the other hand enough tissue can be gained in order to diagnose the lesion. Golden standard between minimal CT-guided

Table 2

Tumor	Incidence Age (yrs)	Male/female ratio	Typical location	Radiological appearance
Osteochondroma	10–30	2:1	Vertebral arch	Pedunculated surface lesion, bony stalk is continuous with adjacent cortex and covered with cartilaginous cup
Aneurysmatic bone cyst	10–20	1:1	Posterior elements	Blow-out lesion, lytic, may have a “soup-bubble“, multiloculated pattern
Osteoclastoma	20–50	1:1.5	Sacrum	Well defined, eccentric, lytic lesion; seldom “soup-bubble“ appearance
Eosinophilic	<30	2:1	Vertebral body	Lytic and sharply demarcated; granuloma “punched out“ intramedullary defects
Hemangioma	Any age	1:1	Vertebral body	Lucent, well demarcated defect, rarefaction with radially oriented striations, “honeycomb“ trabeculated appearance
Osteblastoma	2–30	3:1	Posterior elements	Round or oval, well demarcated lytic defect surrounded by reactive sclerosis
Osteoid osteoma	10–30	3:1	Vertebral arch	Well-demarcated lytic lesion surrounded by a distinct zone of sclerosis

biopsy and open techniques is the Yamshidi needle biopsy. Using needles with a diameter of 0.3–0.5 cm a representative biopsy in a less invasive procedure seems possible.

Once diagnosis is held different therapeutic strategies are described.

Osteochondroma in general does not require surgical therapy. Only in cases of mechanical disturbance local resection of the osseous lesion can be helpful.

In case of diagnosis of an aneurysmale bone cyst further investigations including biopsy is indicated in order to exclude an association of the cyst with chondroblastoma or osteoblastoma. Back pain, scoliosis or acute cord compression requires surgical intervention including curettage, intralesional resection and in case of instability the use of spinal instrumentation.

The entity of a giant cell tumor includes osteoclastoma grade I-III. Concerning the therapy of choice a differentiation between the three types should take place because of the different histopathological behavior. En-bloc resection is indicated absolutely in grade II or III, grade I requires curettage and intralesional resection in order to reduce recurrences reported up to 50% reviewing the literature [58].

Eosinophilic granuloma can lead to vertebra plana. Therefore the children should be treated using a chest tube. The treatment of recurrent eosinophilic granuloma is challenging. The goal is to effectively cure the lesion with minimal short-term and long-term side effects. Systemic steroids, vinca alkaloids, antimetabolites, and antifols are preferred because they have less toxicity and mutagenicity. Combination chemotherapy appears to be an effective method of treating recurrent disease.

Mostly haemangioma does not need any therapy. Symptomatic cases can be treated with radiotherapy, angiography and embolisation or surgical techniques.

Osteoblastoma requires wide surgical resection in order to prevent recurrences.

In osteoid osteoma complete excision of the nidus is the treatment of choice.

Radiation in different entities are followed by complete remission of the lesion, sarcomatous degeneration with the incidence of fibrosarcoma and osteosarcoma and scoliosis arising in children receiving radiation should lead to the indication for radiation in unresectable lesions only.

Minimal invasive techniques like vertebroplasty has been described to treat pathologic fractures in hemangioma, eosinophilic granuloma and aneurysmatic bone cyst without neurologic symptoms [14, 45]. Because of lack of long term follow up examinations, no bony fusion following that procedure and unsure results it should be avoided in younger patients. Curettage of the defect and filling with cancellous bone from the dorsal iliac crest should be therapy of choice.

Primary tumors of the spine are relatively infrequent lesions compared with metastatic disease, multiple myeloma, and lymphoma which are the more frequent neoplasms of the spine and usually manifest with multifocal lesions and thus pose little diagnostic dilemma. However, in the presence of a solitary spinal lesion, the more uncommon primary tumors of the spine represent an important group of entities.

Conclusion

In unclear etiology of pains in the spine benign tumors and tumor like lesions are the second most common diagnosis following trauma in children and adolescents. The most common lesion are hemangioma, eosinophilic granuloma, osteoid osteoma, osteoblastoma, giant cell tumor, an-

eurysmal bone cyst and osteochondroma (Tab. 2). The imaging features of these lesions are often characteristic. Physicians should be aware of the appearance of these tumors in order to provide a complete differential diagnosis.

Therefore in patients with a history of back pain for a longer period of time unresponsive to rest and physiotherapy further diagnostic investigations should be undertaken in order to reveal tumors or tumor-like occult lesions.

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