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Understanding Treatment of Myeloma-Induced Vertebral Compression Fractures

The Role of Vertebroplasty and Kyphoplasty



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A publication of the **International Myeloma Foundation**



Founded in 1990, the International Myeloma Foundation (IMF) is the first and largest organization focusing specifically on multiple myeloma. The IMF's reach extends to more than 525,000 members in 140 countries worldwide. The IMF is dedicated to improving the quality of life of myeloma patients while working toward prevention and a cure through our four founding principles: Research, Education, Support, and Advocacy.

RESEARCH The signature project of the IMF's Research division is the Black Swan Research Initiative®, a groundbreaking and collaborative effort to develop the first definitive cure for myeloma. Each year, the IMF also awards Brian D. Novis Grants, which promote research for better myeloma treatments, management, and practices in the field. In addition, more than 200 leading myeloma researchers comprise the IMF's International Myeloma Working Group (IMWG), a research body that has developed myeloma guidelines that are followed around the world. Finally, the IMF's Nurse Leadership Board (NLB), comprised of nurses from leading myeloma treatment centers, develops recommendations for the nursing care of myeloma patients.

EDUCATION The IMF Patient & Family Seminars and Regional Community Workshops are held around the world to provide up-to-date information presented by leading myeloma specialists and researchers directly to patients and their families. The IMF's library of more than 100 publications, for patients and caregivers as well as for healthcare professionals, is updated annually and available free of charge. Publications are available in more than 20 languages.

SUPPORT The IMF's InfoLine is staffed by trained specialists who answer questions and provide support and information via phone and email to thousands of families each year. The IMF sustains a network of more than 150 support groups and offers training for the hundreds of dedicated patients, caregivers, and nurses who volunteer to lead these groups in their communities.

ADVOCACY The IMF's Advocacy team has educated and empowered thousands of individuals who make a positive impact each year on issues critical to the myeloma community. Working in the US at both federal and state levels, we lead coalitions to advocate for parity in insurance coverage. We also represent the myeloma community's interests before the US Congress and agencies such as the National Institutes of Health, the Food and Drug Administration, the Centers for Medicare and Medicaid Services, and the Veterans Administration. Outside the US, the IMF's Global Myeloma Action Network (GMAN) works to help patients gain access to treatment.

Learn more about the ways the IMF is helping to improve the quality of life of myeloma patients while working toward prevention and a cure.

**Contact us at 818.487.7455 or 800.452.CURE,
or visit myeloma.org.**

Improving Lives **Finding the Cure®**

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What you will learn from this booklet

The IMF's *Understanding* series of booklets is designed to acquaint you with treatments and supportive care measures for **multiple myeloma** (which we refer to simply as "myeloma"). Words in **bold+blue** type are explained in the "Terms and definitions" section at the end of this booklet, as well as in a more complete compendium of myeloma-related vocabulary, the IMF's *Glossary of Myeloma Terms and Definitions*, located at glossary.myeloma.org.

Myeloma is a **cancer** that is not known to most patients at the time of diagnosis. To be empowered to play an active role in your own medical care and to make good decisions about your care with your doctor, it is vital for you to learn as much as possible about myeloma and its treatments. The information in this booklet will help you in discussions with your healthcare team. The more information you have about resources that are available to you, the better and more fruitful that discussion will be.

The focus of this booklet is the vertebral compression fracture (VCF), a serious complication of myeloma, as well as the techniques to provide **supportive care** and to help manage this painful problem. With this booklet, we hope you will be better able to discuss your back condition with your healthcare team and formulate an appropriate plan to alleviate your pain and improve your quality of life.

What are VCFs, and how do they occur?

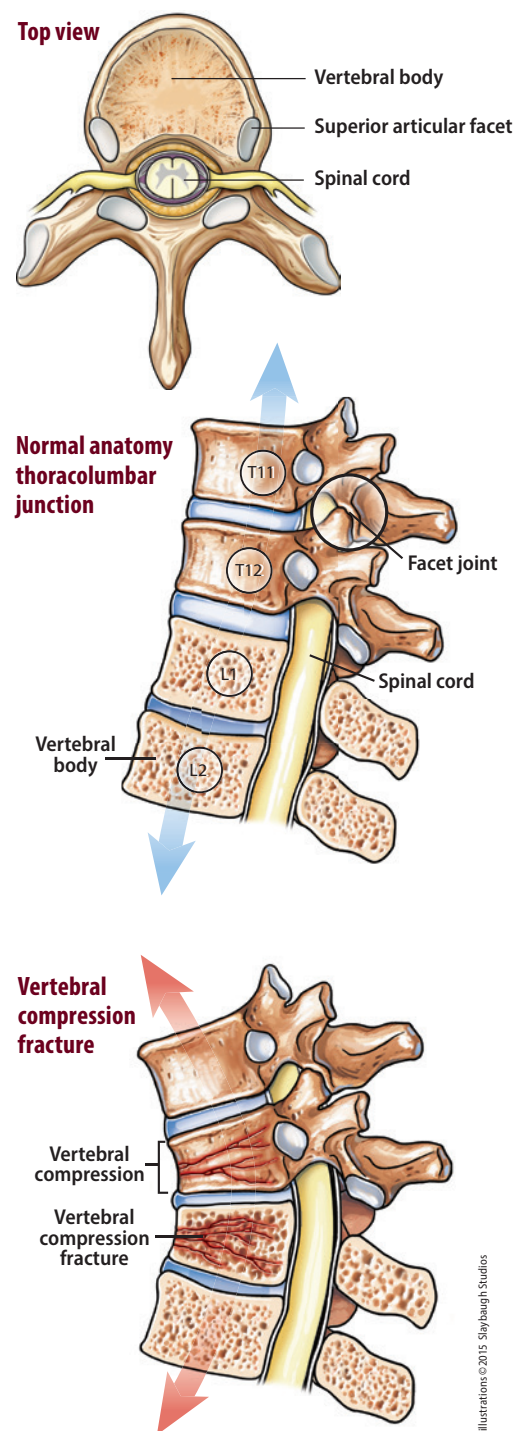
VCFs are fractures of the bones of the spinal column. Because myeloma is a cancer of the **plasma cells** in the bone marrow, cancerous plasma cells (myeloma cells) replace healthy **bone marrow**, often causing widespread destruction of bone and the development of **lytic lesions** or holes in the bone. Lytic lesions occur very commonly in the bones of the spinal column (the **vertebrae**).

Bone is living tissue that is maintained by a delicate interplay between the cells that form new bone (**osteoblasts**) and the cells that remove old bone

(**osteoclasts**). Myeloma cells destroy bone by signaling the osteoclasts to resorb (break down) bone uncontrollably. The myeloma cells spread throughout the skeletal system, causing bone loss that mimics **osteoporosis**. Myeloma also suppresses the formation of osteoblasts. This imbalance between bone-destroying and bone-creating cells further weakens the skeleton.

When a sufficient amount of bone is lost, high levels of **calcium** are released into the bloodstream. This condition is called **hypercalcemia**, and it can occur in patients with myeloma. Hypercalcemia increases bone destruction and frequently impairs kidney function.

Up to 90% of myeloma patients develop bone **lesions** during the course of their disease, and 70% of myeloma patients have bone loss in the spine. Back pain is frequently the symptom that causes undiagnosed myeloma patients to see the doctor in the first place. Sudden severe back pain can indicate that the **vertebral body** of a vertebra has fractured or collapsed. A VCF occurs when the vertebra fractures or collapses because the bone is too weak



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to withstand the pressure or stress placed upon it. Stress on a vertebra can be caused by as little force as gravity acting upon the upright skeleton or can be caused by a fall, twist, bump, cough, or sneeze.

When a VCF occurs, the body's center of gravity moves forward, putting ever more pressure on the vertebrae adjacent to the compression fracture. This can cause a domino effect, resulting in more stress fractures. With multiple fractures, the spine shortens and becomes misaligned, causing a curvature of the spine known as **kyphosis**. Pain occurs both suddenly, as a result of the movement of the fracture fragments, and often secondarily, as a result of the deformity, causing a chronic dull ache in the **facet joint** of the vertebra. As treatment for myeloma improves and myeloma patients live longer and longer, it is especially important to stop this process and reduce the pain and disability that can result from VCFs.

Treatment of VCFs

Analgesics

Analgesics are drugs that relieve pain. They include **nonsteroidal anti-inflammatory drugs (NSAIDs)**, such as aspirin and ibuprofen, and controlled substances available only by prescription. NSAIDs are useful in alleviating mild pain. Because of the risk of gastrointestinal, liver, and kidney toxicity, patients taking NSAIDs – especially myeloma patients who may already have kidney issues and whose other treatments may affect the gastrointestinal tract – must be closely monitored. For severe pain, stronger analgesics can be used. Treatment with analgesics neither prevents additional VCFs nor repairs the fractures.

Radiation

External beam **radiation therapy** provides pain relief in myeloma patients with impending or actual VCFs. Radiation may be used alone or as part of an anti-myeloma treatment regimen. Radiation destroys the cells that make nerve growth factor, and it is particularly effective in cases where a VCF has caused uncontrolled pain. Pain relief is usually achieved several days after radiation therapy. Analgesics may be used along with radiation therapy to alleviate pain until the radiation has an effect. Radiation does not repair fractures and can compromise bone marrow function (all new blood cells are made in the bone marrow). If you are a candidate for autologous stem cell **transplant** (ASCT), radiation can severely impair **stem cell** collection, because these blood-making stem cells live in the bone marrow. Radiation therapy should be performed after vertebroplasty or kyphoplasty. (See booklet section on minimally invasive surgical procedures.)



Bisphosphonates

Bisphosphonates are drugs that bind to the surface of bone, inhibiting the osteoclasts that break down bone. Bisphosphonate therapy is considered standard treatment for patients with myeloma-related bone disease. Treatment with bisphosphonates significantly reduces bone pain in at least 50% of patients and can reduce the frequency of VCFs by 25% to 45%. Bisphosphonate therapy also lessens the need for bone radiation. Myeloma patients who have bone disease usually receive intravenous (IV) bisphosphonate therapy monthly. (See the IMF publication, *Understanding Treatment of Myeloma Bone Disease*.)

Bracing

In some cases, bracing the back may be all that's needed to provide relief from the pain of the VCF and the related pain that the spinal deformity causes on an affected facet joint. The brace, made of thermoplastic material, can provide temporary stability while anti-myeloma therapy is initiated. If the VCF is the presenting symptom of a new diagnosis of myeloma, the most important thing is to initiate **systemic treatment** as quickly as possible in order to get the disease under control. After two or three cycles of therapy, if the pain persists, vertebroplasty or kyphoplasty can be performed. If the brace alone provides relief from the acute fracture pain ("acute" in the medical sense does not mean "sharp" but refers to pain that comes on suddenly and lasts a short time), patients may not need further treatment of the VCF. A myeloma patient who is left with chronic pain of a lower intensity that results from the spinal deformity may benefit from facet joint injections.

Facet joint injection

Image-guided injection of local anesthetic along with a steroid into or around the facet joint, where the bones of the spine meet, can provide relief for the chronic pain that may result when a VCF causes deformity of the spinal column. This procedure is done on an outpatient basis and is low-risk but is not always effective at reducing or eliminating chronic

lower back pain and is not appropriate for the severe fracture pain caused by a VCF. A surgeon experienced with spinal disorders should perform a physical examination to determine whether the patient is experiencing facet joint pain or acute pain from a VCF.

Minimally invasive surgical procedures: vertebral augmentation

Doctors who perform vertebroplasty and kyphoplasty procedures may be **orthopedic surgeons**, **neurosurgeons** who specialize in spinal surgery, or **interventional radiologists**. The type of specialist who does the procedure, and which procedure the doctor prefers to perform, may vary from center to center. The most important considerations are the experience and expertise of the doctor and his or her familiarity with myeloma-related bone disease.

Vertebroplasty

Vertebroplasty was developed in France in the 1980s as a treatment for benign osteoporosis. Bone cement called polymethyl methacrylate (PMMA) is injected directly into the collapsed vertebra to stabilize the fracture and reduce pain. Patients receive either general or local **anesthesia**. Guided by an imaging device, the physician uses a syringe to inject PMMA into the fracture. Patients remain in bed for a minimum of one hour after the procedure in order to allow the cement to harden, and may be able to go home the same day or may require an overnight stay in the hospital.

In some cases, vertebroplasty can restore vertebral body height.

Extravasation (cement leakage outside the vertebra) has been reported in 19.7% of vertebroplasty patients. For most of these patients, extravasation has no noticeable effect, although there have been occasional reports of significant symptomatic complications involving cement leakage following vertebroplasty, including cement pressing on adjacent nerves or chunks of cement traveling to the lungs. Large pieces of cement, or a large cluster of small pieces of cement, traveling to the lungs via the bloodstream is a serious complication and can even be lethal.

The role of vertebroplasty is not entirely clear in myeloma because there are no randomized **clinical trials** of vertebroplasty among myeloma patients.

Balloon kyphoplasty

Published in the *Journal of Clinical Oncology* in 2013, "The International Myeloma Working Group recommendations for the treatment of multiple myeloma-related bone disease" state that balloon kyphoplasty should be considered for symptomatic VCFs and is the procedure of choice to improve quality of life in patients with painful VCFs.



Balloon kyphoplasty is a procedure similar to vertebroplasty in several ways. Like vertebroplasty, balloon kyphoplasty is minimally invasive and uses bone cement to stabilize a spinal fracture, which in turn reduces bone pain and helps increase the patient's overall quality of life. Unlike vertebroplasty, balloon kyphoplasty uses

orthopedic balloons in an attempt to correct the vertebral deformity, restore the height of the collapsed vertebra, and create a void before bone cement is deposited. A straw-like tube called a cannula is inserted in the space between vertebrae, and a balloon is inflated there, creating an open space into which the cement can be injected. After the void has been created, the balloon is deflated and removed, and then bone cement is used to fill the void. The pressure of the balloon forces the damaged pieces of bone to the periphery of the void, creating a dam for the cement. Though cement leakage has been reported in approximately 6% of patients who have kyphoplasty, the controlled filling of the vertebral body reduces the risk of cement leakage below that of vertebroplasty. The disadvantages of kyphoplasty are its increased cost and the increased complexity of the procedure as compared to vertebroplasty.

Study data for vertebroplasty and kyphoplasty

A study published in 2012 in the *Journal of Pain* by Memorial Sloan Kettering Cancer Center and MD Anderson Cancer Center documented the changes in pain and other symptoms in patients with painful myeloma-related vertebral fractures treated with vertebroplasty or kyphoplasty. The researchers concluded that not only pain, but anxiety, drowsiness, fatigue, and depression were significantly reduced after vertebral augmentation with either vertebroplasty or kyphoplasty.

Although there have been no randomized clinical trials of vertebroplasty in myeloma patients, in 2008 the *American Journal of Neuroradiology* published "Vertebroplasty in multiple myeloma: Outcomes in a large patient series," a retrospective review of 67 patients, reporting durable improvements, with 65% of patients requiring fewer narcotics after vertebroplasty and 70% having improved mobility.

A **meta-analysis** of seven non-randomized studies of kyphoplasty in 306 patients with myeloma or lytic bone **metastases** from other cancers demonstrated that kyphoplasty improved pain and function, results that were maintained up to two years post-procedure. Balloon kyphoplasty also improved vertebral height loss and spinal deformity, but these effects were not long-term, according to "Balloon kyphoplasty in malignant spinal fractures: a systematic review and meta-analysis," published in 2009 in *BMC Journal of Palliative Care*.



The International Myeloma Working Group's recommendations for the treatment of myeloma-related bone disease state that the role of vertebroplasty in myeloma remains debatable, not only because no prospective studies of vertebroplasty have been done in myeloma patients, but because two randomized clinical trials in patients with osteoporosis fractures failed to show any benefit with vertebroplasty vs. conservative therapy.

In 2009, the *Journal of Clinical Oncology* published "Management of cancer-related vertebral compression fracture: Comparison of treatment options," a meta-analysis of 59 studies, which showed that balloon kyphoplasty seemed to be more effective than vertebroplasty in relieving pain from cancer-related VCFs and was associated with lower rates of cement leakage.

A study by Roy Xiao and colleagues at the Cleveland Clinic Center for Spine Health, published in *The Spine Journal* in 2015, identified several significant independent predictors of greater fracture progression and development of future fractures in patients with myeloma. Other illnesses myeloma patients might have, such as hypertension (high blood pressure), dyslipidemia (high cholesterol), and **osteopenia**/osteoporosis (a decrease in bone mass and density), were found to predict both rapid vertebral body height loss and increased likelihood for developing future fractures. Xiao and colleagues found that more rapid height loss was associated with a higher body mass index (BMI), high cholesterol, and previous non-vertebral fracture related to myeloma.

Who is a candidate for vertebroplasty or kyphoplasty?

According to the International Myeloma Working Group (IMWG) consensus statement on the role of vertebral augmentation in myeloma, published in 2008 in *Leukemia*, indications for vertebroplasty or kyphoplasty are:

- Persistent significant pain from a fractured vertebral body confirmed on MRI. This can be a fracture that is recent or one that is older and has not healed.
- Persistent significant symptoms affecting daily activities that have not resolved with more conservative measures after four weeks of treatment.
- Especially in newly diagnosed patients, those with very severe pain requiring high doses of analgesics.
- Significant pain affecting activity due to fractured vertebral body.
- Significant pain associated with significant change in disability in conjunction with a new event.
- Acute (recent) VCF delayed for medical reasons.
- Chronic (of older origin) fractures.

Certain areas of the spine are more susceptible than others to progressive collapse after a VCF. The part of the back where the middle **spine** (thoracic spine) joins with the lower spine (sacral spine) is one such area, and the risk for spinal deformity in the area of those vertebrae following a VCF is significant. Patients who have VCFs in the area around the lower end of their thoracic spine and the upper end of their sacral spine should be evaluated for either vertebroplasty or kyphoplasty. Conversely, patients with fractures in the upper thoracic spine (above T-10) seldom need to be treated with vertebroplasty or kyphoplasty because the pain usually can be addressed with more conservative measures, and fractures below the second sacral vertebra (S-2) are not as significant, since the vertebrae in the **sacrum** are fused, and there is more stability in that part of the back.



Any patient whose **spinal cord** is compressed, causing pain or even paralysis as a result of a VCF, should see an experienced spine surgeon who will make treatment decisions in conjunction with the doctor treating the patient's myeloma.

Vertebroplasty or kyphoplasty should NOT be performed if any of the following apply:

- Being unable to tolerate general anesthesia.
- Spinal cord compression.
- Pain unrelated to vertebral collapse.
- Infection at the VCF site.
- Overt instability of the spine.
- Pregnancy.
- Severe cardio-pulmonary (heart-lung) insufficiency.
- Allergy to any of the procedure-related drugs.

Questions to ask the doctor

The following questions are a guide for your discussion with your doctor:

- Do I have pain from a VCF or is this facet joint-related pain?
- Where in my back is the VCF? Is there more than one?
- Do I need to have an imaging study, such as an MRI, to help assess this pain?
- Is swelling around the vertebral body visible on my imaging study?
- Is there a conservative approach to managing this pain, or do I need a surgical procedure?
- If I need a surgical procedure, can you refer me to an experienced surgeon or radiologist who is familiar with myeloma-induced VCFs?
- Would surgery interfere with any other treatment I'm receiving? How should the surgery be timed?
- What are the possible complications of doing a surgical procedure?
- How long will the procedure take, and how long will I have to restrict my activities?
- Would I need general or local anesthesia for the procedure?
- If more than one of my vertebrae is fractured, and I am a candidate for vertebroplasty or kyphoplasty, can either or both of these procedures be performed on more than one vertebra at a time?



In closing

While a diagnosis of cancer is something you cannot control, gaining knowledge that will improve your interaction with your doctors and nurses is something you can control, and it will have a significant impact on how well you do throughout the disease course.

This booklet is not meant to replace the advice of

your doctors and nurses who are best able to answer questions about your specific healthcare management plan. The IMF intends only to provide you with information that will guide you in discussions with your healthcare team. To help ensure effective treatment with good quality of life, you must play an active role in your own medical care.

We encourage you to visit myeloma.org for more information about myeloma and to contact the IMF InfoLine with your myeloma-related questions and concerns. The IMF InfoLine consistently provides callers with the most up-to-date and accurate information about myeloma in a caring and compassionate manner. IMF InfoLine specialists can be reached at InfoLine@myeloma.org or 818-487-7455 or 800-452-CURE.

Terms and definitions

Analgesic: Any drug that relieves pain. Aspirin and acetaminophen are mild analgesics.

Anesthesia: Loss of feeling or awareness. Local anesthesia causes loss of feeling in a part of the body. General anesthesia induces loss of sensation with or without loss of consciousness.

Bisphosphonate: A type of drug that protects against osteoclast activity (bone breakdown) and binds to the surface of bone where it is being resorbed or destroyed.

Bone marrow: The soft, spongy tissue in the center of bones that produces white blood cells, red blood cells, and platelets. This is the tissue within which abnormal plasma cells build up when myeloma is growing.

Calcium: A mineral found mainly in the hard part of bone matrix (hydroxyapatite). If produced or released in excess, it can build up in the bloodstream. See “**Hypercalcemia**.”

Clinical trial: A research study of new treatment that involves patients. Each study is designed to find better ways to prevent, detect, diagnose, or treat cancer and to answer scientific questions.

- **Control group** – The arm of a randomized clinical trial that receives the standard treatment or placebo (no treatment).
- **Experimental group** – The arm of a randomized trial that gets the new treatment.
- **Randomized clinical trial** – A research study in which subjects are randomly assigned to receive a particular treatment or not.
- **Arm** – One of the treatment groups of a randomized trial. The majority of randomized trials have two, but some have more.
- **End point** – The goal of the trial; what a clinical trial is trying to measure or find out. Typical end points include measurements of toxicity, response rate, and survival.
- **Double blind** – Aspect of a randomized trial in which neither the participant nor the investigator knows the arm of the trial to which the patient is assigned. The purpose is to eliminate any bias in the reporting of results.
- **Phase I trial** – A trial designed to determine the maximum-tolerated dose (MTD) of a new drug or a new combination of drugs. It is usually the first human testing of a new treatment, although in phase I trials of combination therapies, the individual elements may already have been well tested. Patients in phase I trials generally have advanced cancer that is refractory to all standard treatment. In a typical phase I trial, successive groups (“cohorts”) of 3 to 6 patients are given the treatment. All patients in a cohort get the same dose. The first cohort typically gets a very low dose, and the dose is raised in each subsequent cohort until a set number of patients experience dose-limiting toxicity (DLT). The dose level used for the previous cohort is then taken to be the MTD. This dose is then used in a phase II trial.
- **Phase II trial** – A trial designed to determine the response rate of a new therapy that has already been tested in phase I trials. Typically, 14 to 50 patients with one type of cancer are treated to see how many have a response. Patients are usually required to have advanced cancer that is refractory to any standard treatment, and in addition, they must have measurable disease. If results from a phase II trial are promising enough, the treatment may then be tested in a phase III trial. If the results are obviously much better than the standard treatment, then it may not be necessary to do a phase III trial, and the treatment may be approved based on phase II trial results.

- **Phase III trial** – A trial designed to compare two or more treatments for a given type and stage of cancer. The end point of a phase III trial is usually survival or disease-free survival. Phase III trials are usually randomized, so patients don’t choose which treatment they receive. A typical phase III trial has 50 to thousands of patients. Some phase III trials compare a new treatment that has had good results in phase II trials with an older, well known, standard treatment. Other phase III trials compare treatments that are already in common use. Some treatments in phase III trials may be available outside the clinical trial setting.
- **Phase IV trial** – Even after a drug has been approved by the United States Food and Drug Administration (FDA) for use in a particular indication, there may be need for additional studies. Phase IV clinical trials may be required by regulatory authorities or may be undertaken by the sponsoring company for a variety of reasons. For example, safety surveillance is designed to detect any rare or long-term side effects over a larger patient population and longer time period than was possible during the phase I–III clinical trials.

Extravasation: Passage or escape of a drug (such as intravenous chemotherapy) or bone cement (during vertebroplasty or kyphoplasty) into surrounding tissue.

Facet joint: The connection between the bones of the spine.

Hypercalcemia: A higher than normal level of calcium in the blood. In myeloma patients, it usually results from bone breakdown with release of calcium from the bone into the bloodstream. This condition can cause a number of symptoms, including loss of appetite, nausea, thirst, fatigue, muscle weakness, restlessness, and confusion. See “**Calcium**.”

Interventional radiology: The branch of radiology concerned with providing diagnosis and treatment of disease by a variety of procedures performed through the skin under the guidance of radiologic imaging.

Kyphosis: An exaggeration of the normal curve of the spine, sometimes referred to as a “hunchback” or “dowager’s hump.”

Lesion: An area of abnormal tissue; a lump or abscess that may be caused by injury or disease, such as cancer. In myeloma, “lesion” can refer to a plasmacytoma or a hole in the bone.

Lytic lesion: The damaged area of a bone that shows up as a dark spot on an x-ray when at least 30% of the healthy bone in any one area is eaten away. Lytic lesions look like holes in the bone and are evidence that the bone is being weakened.

Meta-analysis: An analysis that combines, or pools, the data from multiple scientific studies.

Metastasis: To spread from one part of the body to another. When cancer cells metastasize and form secondary tumors, the cells in the metastatic tumor are like those in the original (primary) tumor. This term is commonly used to describe a disease process in solid tumors (e.g., breast, prostate) and not in myeloma, which is a blood-related cancer.

Multiple myeloma: A cancer of the bone marrow plasma cells, the white blood cells that make antibodies. The cancerous plasma cells are called myeloma cells.

Neurosurgeon: A doctor who performs surgery on any part of the nervous system, including the back and the spinal cord.

Nonsteroidal anti-inflammatory drug (NSAID): A drug used to reduce fever, swelling, and pain.

Orthopedic surgeon: Orthopedic surgeons use both surgical and nonsurgical means to treat musculoskeletal trauma, sports injuries, degenerative diseases, infections, tumors, and congenital disorders.

Osteoblast: A bone cell that is associated with production of bone tissue. Osteoblasts produce osteoid, which becomes mineralized with calcium to form new hard bone.

Osteoclast: A cell found at the junction between the bone marrow and the bone. It is responsible for breaking down or remodeling old bone tissue. In myeloma, the osteoclasts are overstimulated, while osteoblast activity is blocked. The combination of accelerated bone resorption and blocked new bone formation results in lytic lesions.

Osteopenia: A condition in which bone mineral density is lower than normal, but not low enough to be classified as osteoporosis.

Osteoporosis: A progressive bone disease that is characterized by a decrease in bone mass and density, leading to an increased risk of fracture. Diffuse involvement of bones with myeloma produces what looks like osteoporosis on x-ray and bone density measurement.

Plasma cells: Special white blood cells that produce antibodies (immunoglobulins). Myeloma is a cancer of the plasma cells. Malignant plasma cells are called myeloma cells. In myeloma, malignant plasma cells produce abnormal antibodies that lack the ability to fight infection. These abnormal antibodies are the monoclonal protein, or M-protein, that functions as a tumor marker for myeloma. The presence of malignant plasma cells in the bone marrow can lead to organ and tissue damage (anemia, kidney damage, bone disease, and nerve damage).

Radiation therapy: Treatment with x-rays, gamma rays, or electrons to damage or kill malignant cells. The radiation may come from outside the body (external radiation) or from radioactive materials placed directly in the tumor (implant radiation).

Sacrum: Below the lumbar spine is the sacrum, a triangular-shaped bone comprised of 5 fused segments, S1 through S5. The sacrum is inserted like a wedge between the hip bones, with its bottom part connecting with the coccyx (tailbone).

Spinal cord: A long, thin, tubular bundle of nervous tissue and support cells that extends from the brain. The brain and spinal cord together make up the central nervous system. The spinal cord begins at the occipital bone and extends down to the space between the first and second lumbar vertebrae.

Spine: The spine is divided into four main regions. The neck region is known as the cervical spine, comprised of 7 vertebrae, abbreviated as C1 through C7 (top to bottom). The chest region is known as the thoracic spine, consisting of 12 vertebrae, T1 through T12. The lumbar spine in the lower back is comprised of 5 vertebrae, L1 through L5. Below the lumbar spine is the sacrum, a triangular-shaped bone comprised of 5 fused segments, S1 through S5. The sacrum is inserted like a wedge between the hip bones, with its bottom part connecting with the coccyx (tailbone).

Stem cells (hematopoietic stem cells): The immature cells from which all blood cells develop. Normal stem cells give rise to normal blood components, including red cells, white cells, and platelets. Stem cells are normally located in the bone marrow and can be harvested for transplant.

Supportive care: Treatment given to prevent, control, or relieve complications and side effects and to improve the patient's comfort and quality of life.

Systemic treatment: Treatment using substances that travel through the bloodstream to reach and affect cells in the entire body.

Transplant (transplantation): There are several different types of transplantation.

- **Peripheral blood stem cell (PBSC) transplant** – Doctors remove healthy blood-making stem cells from a patient's circulating blood (not from the bone marrow), which are then frozen and stored. The patient receives high-dose chemotherapy to destroy the cancer cells, but healthy blood cells are also destroyed. The frozen stem cells are then defrosted and returned to the patient, where they can produce new blood cells to replace cells destroyed by the treatment.

- **Autologous transplant** – A procedure in which stem cells are removed from a patient’s blood and then are given back to the patient following intensive treatment.
- **Bone marrow transplant** – This term refers to the process of collecting stem cells from the bone marrow and infusing them into a patient. This term is used less frequently today in myeloma as stem cells are now collected from the peripheral (circulating) blood.
- **Allogeneic (allograft) transplant** – The infusion of bone marrow or stem cells from one individual (donor) to another (recipient). A patient receives bone marrow or stem cells from a compatible, though not genetically identical, donor. An HLA blood test is done to determine if a patient has a potential donor match. A donor may be a family member or may be obtained through a donor registry such as the National Marrow Donor Program (NMDP). Rarely, donor cells may be obtained from an umbilical cord blood bank. The donor’s immune system cells recognize the recipient’s myeloma cells as foreign, and attack them. Unfortunately, the donated cells also attack other tissues in the recipient’s body, causing graft-versus-host disease (GVHD), which may be fatal.
- **Reduced-intensity conditioning (RIC) allo transplant** – A newer and, for myeloma, safer technique than an allogeneic transplant. RIC is a non-myeloablative, reduced-intensity “mini-allo” transplant performed within 180 days after a standard autologous transplant.
- **Tandem transplant** – A term used to indicate two autologous transplants done in succession. Tandem transplants are usually planned with 3-month to 6-month intervals between transplants. Tandem transplantation has become less common in the US in the era of effective novel therapies.
- **Matched unrelated donor (MUD) transplant** – Refers to a stem cell transplantation procedure in which the patient and the stem cells are genetically matched but are not from family members. This procedure is not recommended for myeloma patients because it carries an unacceptably high mortality rate from graft-versus-host disease (GVHD).
- **Syngeneic transplant** – The infusion of bone marrow or stem cells from one identical twin into another.
- **Umbilical cord blood transplant** – Stem cells obtained from the umbilical cords of newborns. These are frozen and stored in cord blood banks. Because multiple cords are needed to provide enough stem cells for an adult transplant, the risk of graft-versus-host disease is increased with this type of transplant, making it even riskier for myeloma patients.

Vertebra: Any one of the 33 bony segments of the spinal column.

Vertebral body: The round bony area of a vertebra.

You are not alone. The IMF is here to help.

Myeloma is a cancer that is not known to most patients at the time of diagnosis. To be empowered to play an active role in your own medical care and to make good decisions about your care with your doctor, it is vital for you to learn as much as possible about myeloma and its treatments.

The IMF’s library of educational publications will help arm you with one of the most important weapons in the fight against myeloma: INFORMATION. The IMF publications listed below are available in English, and selected titles are also available in other languages. All IMF publications are free of charge and can be viewed, downloaded, or ordered at publications.myeloma.org

- *Patient Handbook*
- *Concise Review of the Disease and Treatment Options*
- *Understanding Clinical Trials*
- *Understanding Dexamethasone and Other Steroids*
- *Understanding DARZALEX® (daratumumab)*
- *Understanding EMPLICITI® (elotuzumab)*
- *Understanding Fatigue*
- *Understanding High-Dose Therapy with Stem Cell Rescue*
- *Understanding the Immune System in Myeloma*
- *Understanding KYPROLIS® (carfilzomib)*
- *Understanding MGUS and Smoldering Multiple Myeloma*
- *Understanding NINLARO® (ixazomib) capsules*
- *Understanding POMALYST® (pomalidomide)*
- *Understanding REVLIMID® (lenalidomide)*
- *Understanding Treatment of Myeloma Bone Disease*
- *Understanding Treatment of Myeloma-Induced Vertebral Compression Fractures*
- *Understanding VELCADE® (bortezomib)*
- *Understanding Your Test Results*

In addition, the IMF produces an array of **Tip Cards**, concise reference tools on a variety of topics of interest, as well as periodicals such as the quarterly journal **Myeloma Today**, the weekly e-newsletter **Myeloma Minute**. Subscriptions to all IMF periodicals are free of charge at subscribe.myeloma.org

As always, the IMF urges you to discuss all medical issues with your doctor, and to contact the IMF’s trained InfoLine specialists with your myeloma questions and concerns.