Journal Mission

The Journal of Orthopedics for Physician Assistants (JOPA) is an academic resource created to deliver ongoing orthopedic education for physician assistants. The journal is a unique forum to share our knowledge and experiences with colleagues in the profession. JOPA strives to publish timely and practical articles covering all subspecialties. Each article is peer reviewed to ensure accuracy, clinical relevance, and readability.

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**Please see brief summary of Prescribing Information on reverse side.**

For more information, please visit [www.EXPAREL.com](http://www.EXPAREL.com) or call 1-855-RX-EXPAREL (793-9727).

Indications and Usage
EXPAREL is a liposome injection of bupivacaine, an amide-type local anesthetic, indicated for administration into the surgical site to provide an analgesic analgesia.

XPAREL has not been studied for use in patients younger than 18 years of age.

Contraindications
XPAREL is contraindicated in obstetrical paracervical block anesthesia. While XPAREL has not been tested with this technique, the use of bupivacaine for obstetrical paracervical anesthesia has resulted in fetal bradycardia and death.

XPareL is contraindicated for use in patients with a recent history of convulsions or cardiac arrest. Convulsions and cardiac arrest have occurred when bupivacaine was used for epidural anesthesia. While XPAREL has not been studied with this technique, the use of bupivacaine for epidural anesthesia may result in serious adverse outcomes.

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XPAREL is not indicated for use in patients with severe renal impairment (defined as creatinine clearance <30 mL/min).

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XPAREL should not be administered in a setting where trained personnel and equipment are available to promptly treat patients who show evidence of neurologic or cardiac toxicity.

Warnings and Precautions Specific for EXPAREL
As there is a potential risk of severe life-threatening adverse effects associated with the administration of bupivacaine, XPAREL should be administered in a setting where trained personnel and equipment are available to promptly treat patients who show evidence of neurologic or cardiac toxicity.

Caution should be taken to avoid accidental intravascular injection of EXPAREL. Convolusions and cardiac arrest have occurred following accidental intravenous injection of bupivacaine and other amide-containing local anesthetics.

Using XPAREL followed by other bupivacaine formulations has not been studied in clinical trials. Other formulations of bupivacaine may be locally administered after at least 20 minutes of a delay of 20 minutes or more.

EXPAREL in serial dilutions (e.g., Betadine solution) is applied, the site should be allowed to dry before EXPAREL is administered into the surgical site. The plasma bupivacaine measurements did not discern between free and lipid-bound bupivacaine making the clinical relevance of the reported values uncertain; however, no discernable adverse events or clinical sequelae were observed in these patients.

Administration
XPAREL is intended for single-dose administration only. The recommended dose of EXPAREL is based on the surgical site and amount of drug used, and the technique of drug administration. Between 24 and 72 hours after study drug administration, there was minimal to no difference between EXPAREL and placebo treatments on mean pain intensity.

In this clinical study, EXPAREL demonstrated a significant reduction in pain intensity compared to placebo for up to 24 hours. The difference in mean pain intensity between treatment groups occurred only during the first 24 hours following study drug administration. Between 24 and 72 hours after study drug administration, there was minimal to no difference between EXPAREL and placebo treatments on mean pain intensity.

For additional information call 1-855-RX-EXPAREL (1-855-789-7927)
Rx only
May 2015
Intralign is a service line optimization company that assists hospitals and hospital systems in transitioning to the new realities of healthcare. Intralign uniquely combines clinical and operational solutions to create substantial and sustainable improvements to the efficiency of the service line or hospital.

As the largest employer of Surgical Physician Assistants in the country, Intralign Surgical Physician Assistants work at more than 200 hospitals nationwide. Surgical PAs from Intralign have more than 1,700 hours in the OR per year. They are trained at the best-in-class Intralign Academy in surgical and non-surgical skills.

As healthcare changes, Surgical Physician Assistants will play a key role in helping hospitals and surgeons increase the quality and efficiency of surgical care. Intralign Surgical PAs act as a clinical and operational expert in the OR to reduce the sales rep’s influence. As a result, hospitals are able to regain control of operations, reduce costs and improve quality.

Below is Q&A with Intralign Director of Marketing Molly Traugott:

**So how does a PA work for Intralign?**

As a Surgical Physician Assistant with Intralign, a Surgical PA becomes part of an advanced clinical and operational transformation effort that helps the hospital and surgeon become more efficient. Intralign works in partnership with the hospital’s clinical, operational, and administrative teams to optimize the orthopedic surgical episode and reduce sales rep reliance.

**Who would be their supervising physician? Or do you partner a PA with a physician? It would make sense to partner with hospitals so hospitals could force implant companies to train the intralign PAs.**

Intralign starts by partnering with the hospital to create physician engagement and identify rep dependencies. Partnership with the Physician and hospital are both important in ensuring efficiency of the program. Intralign then works with the hospital to establish dedicated surgical teams and more efficient implant procurement procedures. PAs are trained at Intralign Academy in process and clinical skills areas – and implant companies typically rally to provide proper instrument training.

**If I’m an orthopedic PA with several years of experience do I need to go through the Intralign training to be hired?**

When you join Intralign as a Surgical PA, Intralign builds on your skills through an extensive clinical and operational training curriculum offered through Intralign Academy. Intralign Academy orthopedic educational content is developed in partnership with Hospital for Special Surgery and accredited by the AAPA.

By leveraging real-world insight from the most respected industry experts, Intralign Academy improves the surgical support team’s operational and clinical competencies, preparing Intralign Surgical PAs for the rep-less OR.

**If you eliminate reps in the operating room, who is now in charge of product inventory at the hospitals? Surgeons get very anxious about knowing if all implants are readily available.**

For Intralign, materials management is about the combination of efficiencies, process, and training. We work with the hospital to reduce implant variation and improve OR processes, while training Surgical Technicians and hospital staff to effectively manage implant inventory.

**Who is your target in terms of eliminating reps? Is it hospitals to convince them of cost savings, or is it the physician/PA team that you can help train to take over the roll?**

Intralign works in partnership with hospitals, physicians and Surgical PAs to assess
and prepare for less rep dependence:

- Hospitals gain better control of quality and cost in the surgical episode – and efficiencies in the supply chain
- Physicians can access clinically superior support in the OR and increase surgical throughput while retaining implant preference privileges
- The surgical PA becomes a surgical episode change agent with increased influence in the OR process

If a PA is now in charge of implants how are they compensated for the extra responsibility? Is this just for hospital employed PAs or hospital systems? How would this work in private practice?

Intralign Surgical PAs will not be in charge of implants at the hospital. However, all Intralign PAs receive a highly competitive salary and benefits package. Intralign’s rep-less program does not make the PAs responsible for purchasing and inventory tasks. The integrated solution installs efficient procurement, inventory and surgical standards – and empowers the surgical PA to optimize his/her role as the surgeon’s partner.

Please visit http://www.intralign.com/about/careers/ for Intralign career information.

In a recent Forbes’ article, Device Neutrality: A Disruptive Spend Management Strategy, Mark Angelo, Vice President, Innovation & Business Development at the Hospital for Special Surgery, top-ranked in the U.S. for orthopedics and rheumatology, described the role of the Surgical First Assistant going forward: “The reality of the changing healthcare economy is the need to be able to do more with less. For example, Physician Assistants (PAs) are going to play an increasingly important role in scaling care-delivery. The concept of surgeon extenders or surgeon first assistants (SFAs) is also a natural. There is no reason the industry cannot train other care givers to complement the physician in ways that increase their productivity. Device neutrality makes sense to us and our orthopedic surgeons, to the extent that we view it as a potentially significant development for the entire industry.”
Fluoroscopic guidance allows for excellent visualization of intra-articular foot and ankle injections. Locating and injecting into the narrow joint spaces of the ankle, hindfoot, and midfoot without fluoroscopic guidance can be very difficult. Fluoroscopic guidance improves the accuracy and reproducibility of these injections.

Intra-articular placement of steroid injections into the foot and ankle for therapeutic purposes is commonly performed in orthopedic practice. Intra-articular steroid injections also provide valuable diagnostic information in determining the true location of a patient’s pain. Relief of pain after a steroid injection helps rule out extra-articular sources.

Fluoroscopic guidance is commonly used for hindfoot, midfoot, and forefoot injections. The hindfoot consists of the subtalar joint, talonavicular joint, and calcanealcuboid. Therapeutic injections of the hindfoot are commonly performed in adults with post-traumatic arthritis, rheumatoid arthritis, and end stage posterior tibial tendon dysfunction. The midfoot consists of the tarsometatarsal (TMT) joints, the intercuneiform joints, and the navicularcuneiform joint. The most common causes of midfoot pain include posttraumatic arthritis from a Lisfranc injury, osteoarthritis, and rheumatoid arthritis. The first metatarsal phalangeal (MTP) joint is a common forefoot injection performed for arthritic conditions such as hallux rigidus. Fluoroscopic guided intra-articular injections generally provide significant relief for these conditions which allows patients to delay or possibly even avoid surgery. Patients may use a pain diary for 1-2 weeks after the injection to monitor therapeutic response.

Contraindications for the procedure include allergies to contrast material, including both iodine based contrast solution and Gadolinium, injectable anesthetics, or corticosteroids. Relative contraindications include use of anticoagulation medications. Patients who are on aspirin therapy may proceed with intra-articular injection treatment. Patients taking other anticoagulants, including Warfarin, Clopidogrel, Dabigatran, and the like, should stop use of the anticoagulant five days before the intra-articular injection procedure, if medically appropriate. If there is concern whether the patient can come off their anti-coagulant, all of these injections can be done without stopping anticoagulants. The risk of excessive bleeding seems to be minimal if the provider is well trained in the injection techniques. If diabetic patients are receiving a corticosteroid injection, they should be cautioned about possible elevation of their serum blood sugar levels and are advised to adjust their diabetes medications accordingly.

Procedures

Ankle Joint

After the risks and benefits are discussed and written consent is obtained, the patient is placed in a supine position on a radiolucent table. A lead shield is wrapped around the patient’s midsection for protection against radiation.
exposure. The knee of the involved extremity is placed in full extension with the ankle in slight plantar flexion to open the joint space. The injection site is identified using a needle under fluoroscopy. The site should be located just above the talus and medial to the anterior tibialis tendon. Once the site is marked the skin is prepped with Betadine and alcohol. Using 3 mL of 1% plain lidocaine and a 21-gauge 1.5 inch needle, a skin wheal is raised over the injection site. Once adequate anesthesia is obtained, a 21-gauge needle is slowly advanced into the tibiotalar joint using fluoroscopic guidance.

Once felt to be intra-articular, extension tubing is attached to the needle and contrast material (up to 2 mL of Isovue300 and 2 mL saline) is injected into the ankle to confirm position. The general guideline is to use as little contrast or excess fluid as possible in these joints. Particularly the midfoot joints do not tolerate much fluid in the joint space without severe pain for the patient. Contrast material can be seen between the articular surface of the talus and tibia confirming intra-articular placement (Figure 1). Once intra-articular position is confirmed, the joint injection or aspiration can be performed. No resistance should be felt during the injection. For steroid injections, the contrast syringe is removed from the extension tubing and a syringe containing 4 mL of 1% plain lidocaine and 80mg (1 mL) of Depo Medrol is injected. If the practitioner chooses, 1 mL of Betamethasone (6mg/1 mL) may be used in place of the Depo Medrol and 0.25 Marcaine in place of %1 lidocaine.

Subtalar Joint

The patient is placed on the table in a lateral position with the knee flexed and the foot in slight plantar flexion with a towel roll under the medial ankle to open up the joint space (Figure 2). The injection site is identified using a needle under fluoroscopy (Figure 3). The foot is then steriley prepped and draped. Under local lidocaine anesthesia and fluoroscopic guidance, a 21-gauge inch-and-a-half needle is advanced into the subtalar joint, aiming towards the region of the sinus tarsi. Proper intra-articular position is confirmed with contrast material (Figure 4). Up to 4 mL of contrast material (2 mL of Isovue300 and 2 mL saline) may be injected into the ankle to confirm position. Then 40 mg of Depo-Medrol and 3 cc of 1% lidocaine is injected intra-articularly.
**Calcaneocuboid Joint**

The patient is placed on the fluoroscopy table in a lateral position with the knee flexed and the foot in slight plantar flexion with the medial ankle on top of a towel roll for positioning. The joint line is located just superior to the peroneal brevis and peroneus longus tendons as they course to their attachments on the lateral proximal 5th metatarsal and plantar aspect of base of 1st metatarsal and medial cuneiform, respectively. The injection site is identified using a needle under fluoroscopy. The ankle is inverted slightly to open the joint space. The foot is then steriley prepped and draped. Under local lidocaine anesthesia and fluoroscopic guidance, a 21-gauge inch-and-a-half needle was advanced into the calcaneocuboid joint (Figure 5). Proper intra-articular position is confirmed with contrast material (less than 2 mL of Iovue300 and 2 mL saline) using the aforementioned fluoroscopy technique (Figure 6). Once intra-articular placement is confirmed, 40 mg of Depo-Medrol and 1 cc of 1 %lidocaine is injected intra-articularly.

**Talonavicular Joint**

The patient is placed on the fluoroscopy table in the supine position with the knee flexed, the foot slightly plantarflexed on top of a towel roll which is under the midfoot for positioning. Using fluoroscopy, the injection site is located midline. The injection site is approximately 2 cm from the distal medial malleolus. The dorsal pedialis artery should be palpated and avoided. The foot is then steriley prepped and draped. Under local lidocaine anesthesia and fluoroscopic guidance, a 21-gauge inch-and-a-half needle is advanced into the talonavicular joint. Proper intra-articular position is confirmed with 2 cc of contrast material (Figure 7). Then 40 mg of Depo and 1 cc of lidocaine is injected intra-articularly. Sometimes the osteophytes dorsally are so abundant that it is necessary to inject the most medial aspect of the joint with a perpendicular needle orientation versus a straight bulls-eye type of approach into the center midline of the joint.

**Navicular Medial Cuneiform Joint**

The patient is placed on the fluoroscopy table in the supine position with the knee flexed, the foot slightly plantarflexed on top of a towel roll for positioning. Using fluoroscopy, the
injection site is located and marked. The foot is then steriley prepped and draped. Under local lidocaine anesthesia and fluoroscopic guidance, 21-gauge inch-and-a-half needle is advanced into the talonavicular joint. Proper intra-articular position is confirmed with 2 cc of contrast material (Figure 8). Then 40 mg of Depo-Medrol and 1 cc of 1% lidocaine is injected intra-articularly.

**TMT Joint**

The patient is placed in the supine position on a radiolucent table. The knee is flexed and the foot positioned in an oblique fashion on a towel roll under the midfoot to open up the second TMT joint. Using fluoroscopy, the injection site is located and marked. The area is then prepped with Betadine and alcohol. A skin wheel is raised with 1% plain lidocaine. After local anesthesia is obtained, a 21-gauge needle is introduced into the TMT joint under fluoroscopic guidance (Figure 9). The needle is kept perpendicular to the beam. Proper intra-articular position is confirmed with 1 cc of contrast material or using as little as possible to confirm placement. Once the position is confirmed, 40 mg of Depo-Medrol and 1 cc of 1% lidocaine is injected intra-articularly. Often the contrast flows into the 3rd TMT joint and the space between the 1st and 2nd metatarsals which can make injecting the 3rd TMT more difficult. If both joints are to be injected, the dye pattern is more friendly if you inject the 3rd TMT first, and then the 2nd TMT joint. Although the 3rd TMT joint is more technically challenging to inject, this way the dye flows away from the area needed to visualize next due to gravity.

**1rst MTP Joint**

The patient is placed a radiolucent table in the supine position with the knee flexed and the ankle slightly dorsiflexed on top of a towel roll. Using fluoroscopy, the injection site is located and marked. The foot is then steriley prepped and draped. Under local anesthesia and fluoroscopic guidance, a 21-gauge inch-and-a-half needle is advanced into the first MTP joint. Slight traction on the great toe while advancing the needle can help open up the joint space to slip the needle in. Proper intra-articular position is confirmed with 1 cc of contrast material (Figure 10). Once the position is confirmed, 40 mg of Depo-Medrol and 1 cc 1% lidocaine is injected intra-articularly.
Alternative Skin Closure Modality for High-Risk Patients: A Case Report.

Christian Foglar, MD, Donnelle Dubois, PA-C
Advanced Orthopaedics
San Jose, CA

Structured Abstract
This is a case of a high-risk patient who presents with delayed wound healing following a two-stage knee revision surgery and requires a skin closure that can remain in place during the healing phase. Patient presents following a total knee arthroplasty followed by two revisions over a 10-year period. Initial review revealed concern of potential infection with recommendation for a two-stage revision procedure to explant the prosthesis. Patient was at risk of developing wound site infection and required an adhesive-based device that could remain in place for multiple weeks.

Conclusion
An adhesive-based closure device that can remain in place for multiple weeks allows for uncomplicated wound healing so that patient can begin rehabilitation activities and resume normal activities.

Introduction
End-stage osteoarthritis of the knee is often treated with total joint arthroplasty. Over the last two decades, the amount of total knee arthroplasties (TKAs) performed annually has consistently increased. Today, more than 700,000 TKAs are performed in the United States every year. Improvements in surgical technique and the administration of antibiotic prophylaxes have reduced the incidence of post-operative complications following TKA. Nonetheless, adverse events such as infection remain a concern during the post-operative period. Infection rates following TKA vary in orthopaedic literature but are generally in the range of 0.2-2%. The treatment for bone and joint infections involves prolonged antibiotic administration and/or surgical intervention.

We present a case in which a high-risk patient with several co-morbidities presented with multiple post-operative infections following TKA performed by other surgeons. During the patient’s second stage of her fourth revision surgery, we chose an alternative, non-invasive skin closure method that approximated the skin edges and adequately off loaded tension on the wound resulting in a completely healed wound in four weeks. To our knowledge, this is the first such case reported in the orthopaedic literature.

Informed Consent
Our patient in this case report was verbally informed that the data and photos collected during the visits would be submitted for publication and agreed to be included in the review.

Case Report
A 75 year old female with a history of hypertension, hyperlipidemia, BMI >40, diabetes and a past history of incontinence initially underwent a total knee arthroplasty on her right knee in 2002 and had additional revision surgeries in 2011 and 2012 for infections. After the third revision surgery in 2012, the patient was placed on oral antibiotic suppression therapy.

The patient presented to us for a second opinion in June 2014. Her presentation at the consult was right knee diffuse pain, limited range of motion (0-100 degrees) and inability to bear any weight to the right lower extremity. An ultrasound-guided arthrocentesis aspiration of the knee joint was performed. The results of the culture did not show any bacterial growth but did indicate elevated neutrophil (56; normal=0-24) and total nucleated cell (475; normal <150) counts. The patient was sent for a bone scan which suggested possible infection. We ultimately recommended a two-stage revision surgery to explant the prosthesis, place a cement spacer and complete IV/oral antibiotics for 2 months and then re-implant the right knee.

The first stage was performed in October 2014, during which all prosthetic hardware was removed and an antibiotic-impregnated cement spacer was implanted. Wound closure was performed with a deep and superficial layer of
suture and then surgical staples for the skin. The patient tolerated the procedure well and was transferred on postop day number 4 to a skilled nursing facility. The skin staples were removed after 2 weeks and Steri-Strips™ (3M Healthcare, St. Paul, MN) were applied. The patient did not respond well to staple removal and experienced severe pain. The incision continued to drain large amounts of serous fluid for the next 4 weeks, requiring daily dressing changes to absorb the constant oozing from the wound site. The incision was delayed in closure due to the continued drainage. The patient received 4 weeks of intravenous antibiotic therapy, followed by 4 weeks of oral antibiotic therapy.

The second stage of the revision was performed on December 15, 2014. We chose not to use skin staples for post-operative wound closure due to the patient’s previous severe pain with the staple removal; instead, we opted to use an alternative, acrylic and hydrocolloid closure method, called Zip® Surgical Skin Closure (ZipLine Medical, Campbell, CA) that could potentially remain in place for longer than 2 weeks (Figure 1).

The Zip device is designed to approximate the incision edges using a skin-friendly hydrocolloid adhesive combined with ratcheting straps and a load-distribution structure to offload tension and facilitate wound healing. We kept the Zip device on the skin for 4 weeks with no adverse effects. Furthermore, removal of the Zip device did not place any pressure on the incision itself and caused no pain for the patient. The patient had complete closure of the wound at 4 weeks post op (Figure 2). For sensitive patients with a history of post-surgical skin closure complications, we recommend the use of hydrocolloid-based closure modalities that uniformly offload tension, thus placing less stress on the incision edges, and are easier to remove.

**Discussion**

Despite the ongoing reduction of mortality rates following SSI presented in the literature, surgical site infections (SSI) related to joint arthroplasties remain a potentially devastating outcome. There are several risk factors that predispose patients to SSI, including but not limited to diabetes, corticosteroid therapy, high BMI and smoking. The patient, who was diabetic with a high BMI, was at an increased
risk of developing a SSI. In addition to an added infection risk, diabetic patients often display suboptimal wound healing. This patient was no different, as demonstrated by the six weeks it took for her wound to close following our first revision procedure. We believe that tension-offloading, hydrocolloid-based closure modalities are beneficial for such long-term applications. Staples must be removed two weeks post-op to prevent additional complications. Replacing staples with Steri-Strips does not guarantee uniform wound stabilization. We were able to keep the Zip in place for four weeks, and we also found that the removal process was comfortable for the patient. Use of a non-invasive, hydrocolloid-based closure method led to satisfactory wound healing with no additional pain or anxiety to the patient. For high risk patients requiring longer term closure modalities, we recommend that surgeons consider the use of hydrocolloid, tension off-loading, closure devices that can stay in place for a longer duration than surgical staples.

References


[7] Friedman ND, Sexton DJ, Connelly SM, Kaye KS.


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References should be cited using the AMA Manual of Style, 10th edition. References should be recent and predominately drawn from peer reviewed journals. Textbook and website references should be avoided if possible. Article content, including the manuscript body and any tables, should be submitted in Microsoft Word format to facilitate editing. Please use a standard font, such as Times New Roman, and a 12-point font size. Use appropriate headings and subheadings in feature articles to organize paragraphs. JOPA reserves the right to edit content for space and/or grammar issues. Any images that accompany an article must be sent as separate downloadable files from the manuscript text for publishing.

**Featured Review Articles**
Featured review articles should contain a comprehensive review of literature on an orthopedic topic of choice. These academic literature reviews should be heavily referenced and may be co-authored. Subspecialists should consider writing on topics in their fields of expertise. Featured review length should be 4-8 pages. When considering the appropriate length, keep in mind the clinical significance and readability of content.

**Review Articles**
Review articles should be 3-4 pages on an orthopedic topic of choice. Review articles should be selective and include few references. Authors may review a clinical condition, surgical procedure, or any other topic related to orthopedics. Preceptors may consider co-authoring a review article with a PA student interested in pursuing a career in orthopedics.

**Case Studies**
Case studies choose a case and provide a complete history of the clinical presentation, treatment, and outcome. Radiographs and other imaging should be included to follow the course of a diagnosis and treatment. Several learning points should be included at the end of the case study, with appropriate references. Please remove all patient identification information prior to submission.

**Case Reviews and Image Quizzes**
Case reviews present a unique case with several images and a brief description of the presentation, diagnosis, and treatment. Image quizzes include an image for readers to interpret. Answers should be provided, with a brief explanation of the patient and correct diagnosis. Do not include literature review or references for case reviews or image quizzes.

**Be Creative!**
Consider submitting a description of how your practice uses PAs or the relationship you have with your supervising physicians. Consider writing on a patient’s experience and how it could be of value to PA colleagues. Write a detailed narrative of a typical day in your life as a PA. Personal experiences can be some of the most interesting and helpful articles for other PAs to read. If you have any other submission ideas, please contact the editor at dcloutier@thejopa.org.

**Supervising Physicians and Allied Health Professionals**
Supervising physicians may submit articles on topics in their subspecialty or issues related to the PA profession. Physicians may also choose to write on a procedure or service unique to their practice. Co-authoring an article with a supervising physician is a great way to promote the physician-PA relationship. Nurse Practitioners practicing in orthopedics are encouraged to contribute, and may receive a free copy of JOPA by contacting the editor or subscribing online. Contributions from other allied health professionals, such as physical therapists and athletic trainers, give PAs an opportunity to learn from those with whom we share patient care responsibilities. Allied health professionals who wish to contribute to JOPA can contact the editor, Dagan Cloutier, at dcloutier@thejopa.org.
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Designed by Robert L. Thornberry, MD

- Designed to be adjustable yet sturdy when stabilizing a large patient for hip surgery
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- The complete unit is radiolucent and autoclavable except for the foam pads. The pads are made of semi-dense foam to help prevent pressure points and are sealed with a washable coating. The coating also helps to lessen the possibility of skin breakdown.

Durham Offset Zelpi Retractor
Staggered depth retractor designed for exposure during total hip and total shoulder surgery
Designed by Alfred Durham, MD

- In hip surgery, with the handle towards the surgeon, the longer leg is on the inside.
- In shoulder surgery, with the handle downward, the longer leg is on the outside.
- The longer leg extends 1.1" (2.8 cm) deeper.

Offset Handle Hip Retractor
Designed by Gina Bart, PAC

- The 90° offset handle helps move the assistant’s hand out of the way, allowing better access to the surgical site
- During posterior THR, the instrument allows for one assistant to hold the leg while retracting the abductors, thereby maximizing both a clearer view and better physical access to the surgical site.
A 16-year old male presents to your office with approximately 6 years of episodic left knee pain. The pain started during football season but he can’t recall any injury. The pain was sharp in nature and he had difficulty ambulating after games. The pain improved in the off season but continued to bother him on occasion over the years. The pain has progressed over the past several months and now hurts with activities like climbing stairs, jumping, and running. He has occasional swelling but denies any locking or giving way of the knee. His primary care prescribed physical therapy which has not helped.

AP x-ray and coronal T2 MRI image of the patient’s left knee show a 2 cm by 3 cm osteochondral lesion of the medial femoral condyle. There is no linear high T2 signal intensity or cyst formation indicating the overlying hyaline cartilage is intact without gross instability. There is no step-off of the subchondral bone or overlying articular cartilage. During the knee arthroscopy the lesion was probed and found to have a slight ridge over the posterior aspect of the OCD lesion. There was no softening or violation of the articular cartilage.

Which choice is the next best step in treatment?

A. Non-weight bearing for 8 weeks in a hinged knee brace post-operatively
B. Transarticular drilling
C. Osteochondral autologous transplantation
D. Transarticular drilling with placement of bioabsorbable nails

The patient’s left knee x-ray and MRI reveal osteochondritis dissecans with an in situ lesion of the medial femoral condyle. Osteochondritis dissecans (OCD) is a defect in the articular cartilage and subchondral bone that can present in varying degrees of severity. Injury can range from softening of the articular cartilage to detachment of an osteochondral lesion creating a displaced fragment or loose body. Typical presentation includes athletic males below the age of 18 with unilateral involvement. Lesions are most often located in the posterior lateral medial femoral condyle. Pain is usually activity related and poorly localized. Although there is no single known cause of OCD the most widely accepted etiology is repetitive trauma. The pathology starts with softening of the articular cartilage, progressing to cartilage separation, then partial detachment of the lesion, and finally osteochondral detachment.

Most OCD lesions can be seen on x-ray but an MRI is routinely ordered to determine size of the lesion and if the fragment is detached. The Clanton and Delee classification system is used to describe OCD lesions and is divided into 4 progressive stages. Stage 1 is a depression of the osteochondral fracture, stage 2 is a fragment attached to an osteochondral bridge, stage 3 is a detached non-displaced fragment, and stage 4 is a displaced fragment. Lesions assessed arthroscopically can be classified using the International Cartilage Repair Society (ICRS) scale of OCD lesions. Type 1 is a stable lesion.
June Image Quiz: Osteochondritis Dissecans

with softened but intact articular cartilage, Type 2 has partial articular cartilage discontinuity but is stable when probed, Type 3 has complete articular cartilage discontinuity without detachment, and Type 4 is an empty defect with complete detachment or loose body.

Juvenile OCD, occurring in patients with open growth plates, has a better prognosis in terms of healing with non-operative treatment compared to lesions in adults. Stable lesions in children with open physes can be treated non-operatively with a period of non-weight bearing and bracing. The spectrum of non-operative treatment varies widely from non-weight bearing in a cylinder cast for 3 months to 6 weeks of crutch walking with immediate gentle range of motion. Healing rates approach 50-75% with conservative treatment.

Surgery is indicated if non-operative treatment fails in patients with stable lesions. Arthroscopy and transarticular drilling are commonly performed to create vascular channels to the affected bone and cartilage to promote healing. Post operative rehabilitation may include a period of 4 weeks non-weight bearing and a slow, progressive return to activity thereafter. Unstable OCD lesions measuring greater than 2 cm require stabilization with some form of fixation. Arthroscopic techniques for internal fixation include compression screws, k-wire fixation, bone pegs, and bioabsorbable pins and nails. The goal of fixation is to stabilize the lesion, promote healing, and halt the progression of arthritis. Lesions found to be loose during arthroscopy may be peeled back so that debridement can be performed prior to reduction and pinning.

Unstable osteochondral lesions that are completely detached from underlying bone and irreducible should be treated with osteochondral autologous transplantation (OAT). Microfracture (MF) is generally used for smaller detached chondral fragments. OAT procedure has shown improved long term rates of return to sports over microfracture in patients with ICRS grade 3&4 OCD lesions. Both OAT and MF have similar results at one year post operatively. However, due to factors including poor cartilage repair and decrease strength of fibrocartilage reparative tissue with MF, long term results are less favorable compared to an OAT procedure.

References
A 54-year old male presents with a one month history of left hip pain. He is an auto-mechanic and slipped on a patch of wet flooring. He was able to catch himself from falling but in doing so felt a sharp pain in lateral aspect of his left hip. He continued to work after the injury despite having significant pain and limitations secondary to the injury. AP x-ray of the left hip obtained in the office reveals a fracture of the greater trochanter. He denies any history of cancer, weight loss, or fatigue. An MRI is ordered showing a lytic osseous lesion within the left greater trochanter and extending to the surrounding soft tissue.

What is the next best step in treating this patient?

A. CT scans with contrast of the chest, abdomen, and pelvis
B. Skeletal survey
C. Bone Biopsy
D. Open reduction and internal fixation

CT scans with contrast of the chest, abdomen, and pelvis were ordered to determine the primary source of the patient’s metastases of unknown origin. A bone scan was also ordered to determine if other bones were involved. CT scans revealed left and right adrenal masses, an enlarged right kidney, and multiple pulmonary nodules consistent with renal cell carcinoma with metastatic disease to the lungs and adrenal glands. A complete metabolic panel, CBC, ESR, and CRP were also ordered. Pertinent lab results included slight anemia with a hematocrit of 35 and elevated CRP and ESR.

Any new, destructive bone lesion found in a patient over 40 years old should be evaluated for metastatic disease, myeloma, and lymphoma first. The most likely cause of a malignant appearing bone mass in patients over 40 years old is metastatic disease, with lung metastases being the most common source. The pneumonic “bacon, lettuce, tomatoe, kosher, and pickle” is often used to remember the most common sources of metastatic disease “breast, lung, thyroid, kidney, and prostate”. The most common site of bony metastases is the thoracic spine and most common site of pathological fracture resulting from metastases is the proximal femur. Thyroid and prostate metastases tend to be the least aggressive and slow growing with a median survival rate of 48 and 40 months, respectively. Survival rates for breast cancer metastases can vary widely but on average is around 24 months. Patients with kidney and lung metastases have the poorest prognosis with mean survival rates as low as 6 months.

The work-up of a solitary bone lesion requires a detailed history and physical exam. Patients may report a history of prior cancer, bowel or bladder changes, or weight loss. Physical exam of the breasts, skin, chest, prostate, and neck/thyroid is important. Physical exam may pick lymphadenopathy, costovertebral tenderness, abdominal masses or breast masses that may help identify the primary source. Neurological deficits may indicate spinal cord or nerve root compression from a metastatic lesion.

Initial lab work-up should include a CBC with differential, ESR, CRP, complete metabolic panel,
July Image Quiz: Metastases of Unknown Origin

urinalysis, and co-agulation studies. Additional lab work may include a serum protein electrophoresis if multiple myeloma is suspected, a serum carcinoembryonic antigen if colon or pancreatic cancer is suspected, and a serum cancer antigen 125 if there is a risk of ovarian cancer.

Initial imaging work-up for a solitary bone lesion of unknown etiology includes AP and lateral x-rays of the affected limb. Plain x-rays provide the best diagnostic value of any other imaging. CT scan with contrast of the chest, abdomen, and pelvis helps identifying the primary source and can be used in staging the patient’s disease. A bone scan is important in the work-up of a solitary tumor to help differentiate a primary bone tumor vs. multiple lesions from metastatic disease. PET/CT measures metabolic activity such as blood flow, oxygen use, and glucose metabolism to pinpoint the location of abnormal activity produced by a cancerous tumor. PET/CT is more specific for metastatic disease than bone scan. PET/CT is also used to monitor response to therapy. A bone survey, or skeletal survey, is a series of x-rays of the major bones in the body including the skull, ribs, spine, pelvis, and long bones. A skeletal survey is a useful test to evaluate bony involvement in patients with known multiple myeloma as bone scans may be falsely negative in 30% of these patients.

Many orthopedic providers have different thresholds for when to refer patients and when to continue with further work-up of a solitary bone lesion of unknown etiology. If a primary malignant bone tumor is considered in the differential, referral to an orthopedic oncologist is recommended. However, in patients over 40 years old with a solitary bone lesion, a metastatic carcinoma is approximately 500 times more likely than a primary bone sarcoma. A thorough work-up can help avoid inappropriate referral and expedite treatment, which improves patient care.

References
A 17-year old male presents to the office with a mass on the lateral aspect of his right knee. He noticed the mass approximately 6 months ago and doesn’t believe it has grown since. He denies pain at rest but he is starting to have pain over the mass when running. On exam the patient has a firm, nontender 2 cm mass over the lateral supracondylar femur. A positive Ober’s test is noted. AP and lateral x-rays are shown above.

What is the most likely diagnosis?

A. Chondrosarcoma
B. Enchondroma
C. Osteochondroma
D. Osteoid osteoma
E. Chondroblastoma

The patient has an osteochondroma on the lateral supracondylar femur that is causing iliotibial band (ITB) tendinitis.

Osteochondroma, or osteocartilaginous exostosis, is a benign cartilaginous tumor that develops during childhood or adolescence. The tumor most commonly arises from the physes of the distal femur, proximal tibia, and proximal humerus but may occur at other sites. The tumor is essentially part of the physis that separates and continues to grow independently. Osteochondroma is the most common bone tumor accounting for approximately 40% of all benign bone tumors. The tumor usually presents as a painless mass arising from the surface of bone. Large tumors can cause pain by mechanical impingement and neurovascular compression. Osteochondromas will enlarge during skeletal growth and become latent during skeletal maturity.

Multiple hereditary exostoses is an autosomal dominant condition characterized by multiple osteochondromas throughout the skeleton. Almost all patients with the condition will have developed multiple osteochondromas by the age of 12 and new lesions rarely develop after skeletal maturity. Patients with multiple exostoses may present with angular deformities in bone, growth disturbances, and limb length discrepancies. Multiple sites of exostoses have a higher rate of malignant transformation to chondrosarcoma as does persistence of greater than a 2 cm cartilage cap after skeletal maturity. A solitary osteochondroma has a 1% percent chance of malignant transformation compared to
August Image Quiz: Osteochondroma

a 10% chance in patients with multiple hereditary exostoses.

X-rays alone can make the diagnosis of an osteochondroma. X-rays will reveal an exostosis that may have a sessile (flattened) or pedunculated (stalk-like) appearance. The cortex of the lesion is continuous with the cortex of the native bone. The mass has a thin 2-3 mm cartilaginous cap that may be visualized on x-ray as irregular calcifications. MRI is the best image modality to measure the cartilage cap and assess for potential malignant transformation.

Treatment includes observation in asymptomatic patients. Operative treatment may be indicated in lesions that cause pain, mechanical impingement, deformity, or neurovascular compression. Operative treatment includes a marginal resection that includes the base of the stalk, the cartilage cap, and overlying periosteum. Cartilaginous growth of over 1.5 cm in a dormant osteochondroma or after skeletal maturity may signify malignant transformation and surgical resection should be performed. The recurrence rate after marginal excision of a solitary exostosis is less than 5%.

Chondrosarcoma is a malignant cartilage lesion more common in males (male to female ratio is 1.5 to 1) in their 40s to 80s. There are multiple subtypes with a variety of presentations making it difficult to diagnose and treat. Chondrosarcomas are generally found in the metaphysis of long bones and typically present with a history of constant, progressive pain not relieved with rest.

Enchondroma is a solitary, benign, intramedullary cartilage tumor, often occurring in the short tubular bones of the hands, feet, or proximal long bones. Typically, this tumor causes no symptoms and is found incidentally on x-rays taken for another complaint. They usually begin and grow in childhood; peak incidence is in the third decade of life and equal between males and females. Incidence for transformation to a malignant tumor is rare (1%).

Osteoid osteoma is a benign bone tumor, usually in the proximal end of long bones that can affect people of all ages. Male to female ratio is 2-3 to 1. They are small (< 2 cm) but may have surrounding reactive bone formation. Typical presentation is a moderate intensity, dull, aching, pain which may or may not respond to NSAIDS. Most will disappear after a few years.

Chondroblastoma is a rare, benign bone tumor derived from chondroblasts. Most commonly found in the epiphysis of long bones around the knee, hip, shoulder, or elbow. Although it can affect anybody, 80% occur by the age of 25 and males are twice as likely as females to get chondroblastomas. The most common symptom is pain, but may include joint stiffness, muscle atrophy, or a limp. A chondroblastoma does have potential to metastasize.

References


Osteoporosis is a disease characterized by a progressive decline in bone mass and strength leading to an increased risk of fracture. An estimated 52 million people have low bone mass with studies showing one and two women will break a bone due to osteoporosis. Osteoporosis causes 2 million fractures each year with a predicted 3 million fractures occurring annually by 2025. This accounts for 19 billion in health care costs annually and an expected 25 billion annually by 2025.1

Despite the epidemic in fragility fractures many osteoporotic patients are never identified or treated. The burden of screening patients before a fragility fracture occurs usually falls on the already busy primary care providers. A shortage of primary care providers in today’s healthcare results in poor access and under treatment. Furthermore, patients who have experienced an osteoporosis related fragility fracture rarely follow-up with their PCP for further work-up. The rate of evaluation and treatment for osteoporosis is as low as 8% in patients who have sustained a fragility fracture.7

So how do we solve the lack of recognition and treatment of osteoporosis? All patients who sustain an osteoporotic related fracture will be seen by an orthopedic provider at some point. For this reason orthopedic providers, including orthopedic surgeons and orthopedic physician assistants, have a valuable opportunity to play a larger role in recognizing and treating osteoporosis. Orthopedic providers should go beyond treating the existing fragility fracture by ensuring the underlying cause of the fracture is identified and treated as well.1

A growing solution to the lack of PCP follow-up after a fragility fracture is the creation of a bone health program or fracture liaison service within an orthopedic practice. A physician assistant or nurse practitioner who specializes in osteoporosis is an ideal provider to run the program. Osteoporosis education and screening tests are first discussed by the orthopedic provider treating the fracture. Patients are then instructed to follow-up with an osteoporosis specialist within the practice who can interpret test results and begin appropriate treatments or a referral to the primary care physician is made if the patient so chooses. Either way, the patient is educated and screened in an orthopedic setting which has been shown to improve compliance. Rozental et al found that when an orthopedic surgeon initiated BMD testing after a fragility fracture patients were three times more likely to be tested compared to compliance when a letter was sent to the PCP recommending doing so. Having a bone health program within an orthopedic practice ensures communication between treating providers is optimized and gives patients a single site for all inclusive bone health care.

This article aims to provide physician assistants with a comprehensive review of the diagnosis and treatment of osteoporosis. Orthopedic physician assistants should be discussing the screening and treatment of osteoporosis in all patients over 50 years old who have sustained a distal radius, vertebral, or hip fracture. This valuable education will help reduce the risk of future osteoporotic related fractures in our patients.

**Pathophysiology**

The magnitude of bone mass is determined largely by heredity but other factors may have an influence including physical activity, muscle strength, diet, medications, and hormones. Peak bone mass is attained between the ages of 18 and 25 and then slowly declines with aging. Age related changes to bone include a microarchitectural deterioration of trabecular bone, loss of cancellous bone, and a loss of bone collagen. Trabecular bone is lost over time to a greater extent than cortical bone.

Bone density is determined at the cellular level with two types of cells on the surface of bone called osteoblasts and
osteoclasts. Osteoblasts are cells that are responsible for synthesizing bone. Osteoblasts have receptors for parathyroid hormone (PTH), vitamin D, and estrogen. Osteoclasts are cells that break down bone to release calcium, phosphorus, water, and other substances into the blood. Osteoclasts are regulated by parathyroid hormone, calcitonin, certain growth factors, and other hormones including estrogen. The level of bone mass remains constant when osteoblastic activity equals osteoclastic activity. After menopause and with aging bone density reduces as osteoclastic activity increases and begins to outpace osteoblastic activity.8

Several endocrine organs including skin, parathyroid glands, liver, kidneys, gonads, adrenals, and thyroid act to regulate bone metabolism in order to maintain adequate serum calcium levels. Calcitonin is a hormone secreted by the thyroid that helps regulate serum calcium and phosphorus levels by targeting receptors on bone, kidneys, and the gastrointestinal (GI) tract. It acts to reduce blood calcium levels by inhibiting GI absorption, inhibiting osteoclastic activity in bones, and inhibiting renal reabsorption.8 In contrast, parathyroid hormone secreted by the parathyroid gland acts to increase calcium in the blood by targeting receptors on bone and the kidneys. PTH increases GI calcium absorption, increases osteoclastic activity, and increases renal reabsorption.

Osteoporosis Classification

There are two main types of osteoporosis: primary and secondary types. Primary osteoporosis has three subtypes: 1. Postmenopausal, 2. Age-associated, and 3. Idiopathic. Secondary osteoporosis is caused by an identifiable underlying medical condition.

Postmenopausal osteoporosis is the most common type, particularly in women between the ages of 50 and 75 years of age.6 Around the age of 51, or the average age of menopause, estrogen levels circulating in the body decline rapidly resulting in a shift toward increased bone resorption.2 Women can experience a 3-5% yearly rate of bone loss for 5-7 years after menopause. Women who have surgical menopause at a young age will have an increased risk of osteoporosis due to prolonged estrogen deficiency. Women who smoke or who have a lower body weight tend to experience menopause earlier than the average age as well.13

Age related osteoporosis affects men and women over the age of 70.8 The intestine's ability to absorb calcium and the skin's ability to form vitamin D is reduced with aging. Osteoblastic activity also slows and new bone formation is decreased. Reduced activity level associated with a more sedentary lifestyle in the older population also increases the rate of bone loss over time. Women are more commonly affected; half of all women will have osteoporosis by age 80. Women over 50 years old are over twice as likely to sustain a hip fracture compared men of the same age.8

Secondary osteoporosis is relatively common considering 30% of women and 55% of men who sustain a vertebral fracture will have a medical condition causing diminished bone strength.35 Common medical conditions that cause secondary osteoporosis may include hyperparathyroidism, hyperthyroidism, Cushing's syndrome, and malnutrition. Other causes of secondary osteoporosis may include drug induced; heparin use more than 4-5 months, steroid use, chemotherapy agents, and excessive alcohol intake.

Hyperparathyroidism

A common presenting complaint of hyperparathyroidism is a previous fracture due to underlying osteoporosis. Patients may also complain of a history of kidney stones, headaches, fatigue, and depression. “Moans, groans, stones, bones, and psychic overtones” is commonly used to remember the symptoms of hyperparathyroidism. The parathyroid glands (4 total) regulate blood calcium levels by controlling resorption from the bone, intestines, and kidneys. Primary hyperparathyroidism occurs when one of the parathyroid glands grows into a tumor that secretes excessive parathyroid hormone (PTH). Elevated PTH levels cause excessive calcium in the blood or hypercalcemia. The excessive resorption of calcium from bone over time results in loss of bone density and an increase risk of fracture. If a patient is found to have elevated PTH and calcium levels a sestamibi scan may be ordered to help confirm the diagnosis of a parathyroid tumor. Surgical excision is the only way to treat parathyroid disease. When the tumor is removed PTH levels will return to normal levels and the patient’s bone density will begin to improve over time. No further treatment with osteoporosis medications is required.

Secondary hyperparathyroidism, commonly seen in renal failure patients, result
from an elevated PTH level in response to a hypocalcemia state. One example; renal osteodystrophy is a consequence of untreated secondary hyperparathyroidism in renal failure patients. Secondary hyperparathyroidism may also occur in patients with vitamin D deficiency, post-gastric bypass, and occasionally celiac disease. Obtaining calcium and phosphorus levels can help differentiate between primary and secondary hyperparathyroidism. In primary hyperparathyroidism calcium is high and the phosphorus is low while in secondary hyperparathyroidism calcium is low and the phosphorus high.

**Initial Laboratory Work-Up to Screen for Secondary Osteoporosis**

A detailed review of the patient’s past medical history should be reviewed for genetic risk factors, hypogonadal states, endocrine disorders, gastrointestinal disorders, hematologic disorders, rheumatic and autoimmune diseases, alcoholism, as well as other disorders that could contribute to low bone mass. Past and current medication use that may lower bone density should be identified and may include heparin, anticonvulsants, aromatase inhibitors, barbiturates, chemotherapy drugs, deoxy-merchantosterone, glucocorticoids (> 5 mg/d of prednisone for > 3 months), gonadotropin releasing hormone agonists, and lithium.

Initial laboratory studies should, at minimum, include a serum 25-hydroxy vitamin D level, complete metabolic panel (CMP), and an intact PTH. Patients with risk factors for secondary osteoporosis may require a more comprehensive work-up and should be referred to an endocrinologist. Labs ordered in further work-up may include a CBC, UA, TSH, serum protein electrophoresis (SPEP), cortisol, serum albumin, 24 hour urine calcium, and a serum-free testosterone.

Biomechanical markers that follow bone turnover can also be obtained in blood and urine tests. Markers for bone resorption include a serum C-telopeptide (CTX) and urinary N-telopeptide (NTX). Both CTX and NTX are biproducts of type 1 collagen breakdown by osteoclasts. Serum bone specific alkaline phosphatase (BSAP) and osteocalcin are markers of bone formation. These markers are also helpful in determining how well pharmacological agents are working over time. Changes in bone formation markers can be seen as early as two months after initiation of treatment. Elevated urine NTX and serum CTX levels indicate increased bone resorption which can occur after treatments have been stopped. Obtaining a baseline level before starting drug therapy is recommended to compare to levels during treatment and when medications are stopped. A >50% reduction after 3-6 months of therapy indicates an adequate therapeutic response. If serum CTX and urine NTX levels trend upward during a drug holiday then medications should be restarted.

A complete metabolic panel (CMP) helps screen for cancers that may affect bone including multiple myeloma and lymphoma (low red cells, white cells and platelets) and Leukemia (high white cells, low red cells and platelets). A 25(OH) vitamin D measurement is used to determine adequate vitamin D intake and subsequently determine how well calcium is being absorbed.

A complete metabolic panel typically includes an albumin, alkaline phosphatase, AST, ALT, BUN, Creatinine, Calcium, Chloride, CO2, Glucose, sodium, potassium, total bilirubin, and total protein. Albumin levels that are high or low may cause falsely reported calcium levels and a correction factor may be used to accommodate this. BUN and Creatinine levels are essential in determining renal function prior to the start of...
many medications used to treat osteoporosis. An elevated alkaline phosphatase level may indicate a process breaking down bone including bone tumors or Paget’s disease.

Calcium levels should be within normal limits prior to starting therapeutic agents. Causes of hypercalcemic states include primary and secondary hyperparathyroidism, sarcoidosis, metastatic bone disease, multiple myeloma, hyperthyroidism, diuretic use, and ingestion of aluminum containing antacids. Hypocalcemia is much less common and may be due to underlying hypoparathyroidism (most commonly caused by post surgical parathyroidectomy) or poor nutrition due to inadequate calcium intake.

A 24-hour calcium level measures the amount of calcium excreted in the urine. Common causes of hypercalciuria include excessive calcium supplementation, hyperparathyroidism, and primary (idiopathic) hypercalciuria or “renal leaking”. Hypercalciuria due to increased gut absorption can be lowered with a dietary restriction; repeating the 24 hour urine calcium after a calcium restriction helps differentiate increased gut absorption from other conditions. Primary hypercalciuria can result in bone demineralization and an increase risk of osteoporosis. Primary hypercalciuria is autosomal dominant so patients with a family history of kidney stones should raise suspicion of renal leak osteoporosis. Men with primary hypercalciuria have a higher propensity for kidneys stones where women present more commonly with osteoporosis. If primary hypercalciuria is discovered the patient may benefit from HCTZ treatment. If sarcoidosis is suspected in patients with hypercalciuria then a chest x-ray should be ordered.

Work-up of multiple myeloma should be considered in patients with a fracture of the vertebral spine, particularly in patients who have normal to osteopenic bone density. Multiple myeloma(MM) is a plasma neoplasm that causes overproduction of monoclonal proteins. These proteins can proliferate in bone or be deposited in the organs. Common complications at the time of MM presentation include anemia, renal failure, and vertebral fracture. Hypercalcemia may be noted as MM begins to break down bone. A serum protein electrophoresis (SPEP), a urinary protein electrophoresis (UPEP), and an immunofixation (IFE) test can make the diagnosis of MM and help stage the disease. An MRI of the vertebral spine is also very helpful in determining if lytic lesions from MM are present causing a pathologic fracture.

Celiac disease may also be a cause of a calcium malabsorption and osteoporosis. A screening test for celiac disease including a tTg-IgA test, endomysial antibody IGA, and a reticulin IGA may be warranted. Celiac disease damages the lining of the intestines which inhibits the body’s ability to absorb calcium.

A thyroid stimulating hormone (TSH) is commonly ordered to screen for hyperthyroidism. Labs indicating hyperthyroidism include a low TSH and elevated T3 and T4 levels. Hyperthyroidism increases bone turnover by increasing the number of osteoclasts and resorption sites resulting in a net loss of cortical and trabecular bone. Patients on long term levothyroxine (T4) for hypothyroidism may be at an increased risk for osteoporosis. Excessive intake of thyroid supplements can result in subclinical hyperthyroidism which most commonly occurs in the elderly population. High doses of levothyroxine in the elderly population have been shown to increase the prevalence of fractures in these patients. When too much levothyroxine is taken, the pituitary gland senses high levels of thyroid hormones in the body and decreases secretion of TSH; low TSH levels may indicate overtreatment.

Because a laboratory work-up is often done in the early post fracture period, clinicians should be aware of potential elevation of alkaline phosphatase (ALP) levels after a fracture. The two most common sources of elevated serum alkaline phosphatase levels are bone and liver. Bone specific alkaline phosphatase (BSAP), an isoenzyme of ALP, is secreted by osteoblasts and is a useful marker of bone formation. ALP levels may start to increase as early as one week after a fracture and usually resolves 8 to 12 weeks post fracture. An elevation in ALP may also raise concerns of skeletal malignancy or Paget’s disease with both conditions being contraindicated with teriparatide use. If teriparatide use is being considered, clinicians may consider waiting for mild ALP elevations to subside over time. Measurement of gamma-glutamyltransferase helps to identify a hepatobiliary source of an elevated ALP. A full body bone scan to rule out skeletal malignancy may also be appropriate prior to teriparatide administration if the ALP is persistently elevated. 

A testosterone level may be warranted in men with symptoms of a hypogonadal state.
such as fatigue, decreased libido, and erectile dysfunction. Testosterone replacement therapy has been shown to increase bone mineral density in patients with low measured levels.\textsuperscript{22} If bone density remains low in high risk patients on testosterone therapy then anti-fracture pharmacologic agent should be added.\textsuperscript{22} Once hypogonadal states have been ruled out, treatment approach with a pharmacological agent in men with primary osteoporosis should be the same as in women with osteoporosis.

**Diagnosing**

Past guidelines for defining and diagnosing osteoporosis have often been determined by bone mineral density (BMD) testing alone. A T score of \(< -2.5\) establishes the diagnosis and effectively identifies patients who are at an increased risk of fracture. Recently, organizations such as the National Osteoporosis Foundation (NOF) and the National Bone Health Alliance (NBHA) have further recognized that a history of a low trauma fracture or “fragility” fracture is also an accurate predictor of a future osteoporotic related fracture. The NBHA now recommends that patients over 50 years old who experience a low trauma hip fracture, or patients that are osteopenic by BMD and who sustain a low-trauma vertebral, proximal humerus, pelvis, or distal forearm fracture should meet the diagnostic criteria for osteoporosis. Fractures at these sites are strongly associated with low BMD and osteoporosis. This diagnostic criteria has helped identify a significant population of patients who have sustained an osteoporotic related fracture and who should be treated.

**Bone Mineral Density Measurement and Classification**

Dual-energy x-ray absorptiometry (DXA) scan evaluates bone density to confirm the diagnosis of osteoporosis and helps predict the risk for future fracture. The hip and vertebrae are the most common sites measured because of the high correlation between low BMD and fracture risk at these sites. Any adult over 50 years old who presents with a suspected fragility fracture should have a DXA scan. DXA scans report density as a relationship to two norms: a Z-score compares what the expected BMD would be for
the patient’s age and sex and a T-score compares BMD to a “young normal” adult of the same sex. In women the “young normal” adult is calculated from a database of Caucasian women between ages 20-29 years old. Scores are reported as standard deviations above or below the mean for each. The World Health Organization (WHO) uses bone mineral density of the femoral neck and lumbar spine in DXA measurements. (WHO) reports a normal BMD as a T-score within 1 standard deviation of a “young normal” adult. A T score between -1.0 and -2.5 is considered osteopenia. A T score equal or below -2.5 is diagnostic of osteoporosis. A T score equal or below -2.5 in the presence of a fragility fracture is often referred to as severe osteoporosis. These values exclude premenopausal women, men under 50 years old, and children. The International Society for Clinical Densitometry (ISCD) recommends the use of Z-scores in premenopausal women, men under the age of 50, and children. A Z-score of -2.0 or lower is defined as low bone mineral density for chronological age or below the expected range for age. A Z-score below -2.0 raises suspicion of secondary osteoporosis and further work-up should be done.

DXA scans use an enhanced form of x-ray technology and a small amount of ionizing radiation to measure bone density. Central DXA scans evaluate BMD of the hip and vertebrae where peripheral DXA scans use portable devices to evaluate the extremities. Central DXA scans are more accurate and more sensitive to changes in BMD. Central DXA scans require patients to lie on a table, usually for less than 15 minutes, during the scan. The procedure is painless and doesn’t require any sedation or pre-procedural fasting. Patients are advised to avoid taking calcium supplementation the day of the exam as the calcium can cause inaccurate bone density results. A lateral vertebral fracture assessment (VFA) is a test performed on the DXA machine that screens for vertebral fractures in patients who have lost more than an inch of height. Up to two-thirds of vertebral fractures are asymptomatic so a VFA is an important screening test in these patients.

Patients who have sustained a prior lumbar fracture, have severe degenerative spine disease, or who have had hip or spine surgery may have falsely elevated BMD measurements and central DXA scans at the affected sites should be avoided in these patients. A peripheral DXA is necessary in patients that cannot have their hip or lumbar spine measured. Patients who have sustained a fragility fracture of the hip or vertebrae may not need a DXA measurement to start treatment given the high risk of additional fractures. However, in these patients a baseline DXA is helpful to guide treatment decisions and to help monitor BMD changes after therapies have been initiated.

“Quality vs Quantity”

Healthcare providers routinely look at patient’s T scores to determine bone density and gauge bone strength. However, many patients sustain fragility fractures with normal to osteopenic T scores. Osteopenic patients far outnumber osteoporotic patients; 9 million Americans have osteoporosis compared to a suspected 48 million with osteopenia. The majority, or 55%, of patients who sustain a hip fracture are osteopenic on DXA. The explanation for this discrepancy is often described as “it’s about bone quality not quantity”. But what does this mean? There are many factors that cannot be measured by a diagnostic test with bone quality being one of them. Factors affecting bone quality may include accumulated microscopic damage, the quality of collagen, the size of mineral crystals, and the rate of turnover. The Fracture Risk Assessment Tool (FRAX) score is a great tool that uses several risk factors to determine fracture risk with or without a DXA scan.

**The Fracture Risk Assessment Tool (FRAX)**

The Fracture Risk Assessment Tool (FRAX) was developed by the World Health Organization and is used to calculate fracture risk with or without BMD testing. However, predictions are more accurate when BMD scores are used in the calculation. FRAX calculates the probability of future fracture in both men and women based on several risk factors. These include patients height, weight, gender, ethnicity, BMD, history of fragility fracture after 45, current smoker, alcohol Use (> 3 drinks per day), steroid use (> 5 mg daily for 3 months), the presence of Rheumatoid Arthritis, history of a parent who sustained a hip fracture, and secondary osteoporosis. FRAX estimates the 10-year probability of a hip fracture and major osteoporotic fracture (hip, spine, proximal humerus, and forearm) in untreated patients between the ages 40-90 years-old. The tool is validated using BMD from the femoral neck only. The calculated percentage
risk of a future fracture helps guide treatment decisions, particularly whether or not to start a pharmacological agent. According to the FRAX score patients with a 10-year probability of a major osteoporotic fracture exceeding 20% and a 10-year probability of a hip fracture exceeding 3%, should be treated with a therapeutic agent regardless of the T-score.

**Fragility Fracture**
Fragility fractures occur with a fall from a standing height or less in the absence of obvious trauma. In this setting a pathological fracture should be ruled out first and further work-up should be done in patients with a history of cancer. With a healthy bone mass the body should be able to withstand this type of fall without a fracture occurring. Osteoporosis or low bone mass should be suspected with a fragility fracture and further work-up is necessary. In patients with severe osteoporosis, every day activities like bending over and lifting may result in a vertebral fracture. Risk factors for fragility fractures include female, increasing age, postmenopausal, Caucasian race, weight under 127 lbs, smoking, and a history of a prior fracture. On average, Asian, Black, and Latino women have a higher BMD than Caucasian women.

Anyone with a previous fragility fracture is 2-4 times more likely to sustain another fracture compared to the general population. Up to half of all patients with a prior vertebral fracture will sustain another fracture in the same year which is five times more likely than individuals with no history of fracture. Women who have experienced a hip fracture are six times more likely to have another. Many patients that have sustained a fragility fracture have significant long term pain and disability. Hip fractures alone carry a 10-20 percent mortality rate within the first year. Future fragility fractures can be reduced by up to 50% if proper treatment is initiated after the first fragility fracture occurs.

This data points out that optimal care of fragility fractures goes beyond management of the presenting fracture. A number of medications have been proven to reduce fragility fractures yet many patients with osteoporosis go untreated. Rabenda et al looked at 23,146 postmenopausal women who had experienced a hip fracture and found that just 6% of these patients received anti-osteoporosis treatment. For the patients that did undergo treatment, only 41% continued the medication though the first year. The study also observed a decreased mortality rate in the treated group as compared to the untreated group (11% compared to 37% respectively).

**Treatment**
Initial treatment consists of counseling patients on reducing risk factors for fragility fracture. A regular weight bearing exercise routine should be started to improve strength and balance which helps reduce fall risk. A review of possible neurological and musculoskeletal disorders should be done to identify patients at an increase risk of falling and appropriate precautions should be recommended. Patients can also help reduce fall risk by having their vision and hearing checked on a regular basis. Medications that may cause hypotension or dizziness should be reviewed with the patient and discontinued if medically safe. Home safety measures include removing objects that can be tripped over, installing hand rails and grab bars, and improving indoor lighting. Patients should be advised to stop tobacco and excessive alcohol use (more than 2 drinks per day) as both can have negative effects on bone health. An educational handout on the above safety measures is helpful for patients to reference at home.

**Fall Risk Assessment**
A brief fall risk assessment should be performed in patients with two or more falls in the past year or any fall with injury in the past year. According to the Center for Medicare and Medicaid Services (CMS), a fall can be defined as a sudden, unintentional change in position causing an individual to land at a lower level, on an object, the floor, or the ground, other than as a consequence of sudden onset of paralysis, epileptic seizure, or overwhelming external force. Any compromise of balance and/or gait and one or more of the following: postural blood pressure, vision, home fall hazards, and documentation on whether medications are a contributing factor or not to falls within the past 12 months should be noted.

Several pertinent observations should be noted in the dictated exam. The patient’s height, weight, and race are pertinent facts. Note the patient’s mental status including level of alertness and orientation to person, place, and time. The patient’s ambulatory status should be documented and may be characterized as an independent
ambulator, or requires assistance of a cane, walker, or wheelchair. Patients with a history of visual impairment such as cataracts, glaucoma, and blindness should have documentation that they see an eye doctor on a regular basis. The “Get Up and Go” test is a commonly used gait assessment to help determine a person’s risk of falling. The test requires patients to get up from a seated position in a chair, walk approximately 10 feet, turn around, return, and sit back down again. Any difficulty in getting out of a chair as a result of muscle weakness, poor posture, or falling back should be noted. During ambulation, any antalgic gait, poor postural control, or assistive device use should be noted.

**Calcium and Vitamin D**

Adequate calcium and vitamin D intake is universally recommended for osteoporosis. Calcium and vitamin D supplements are well tolerated and the combination has been shown to reduce the risk of fracture. Daily recommendations for each vary widely but most include 800-1,200 mg of calcium and between 1,000 to 2,000 IU of vitamin D daily.

Calcium, the most abundant mineral in the body, helps regulate muscle, nerve, cellular, and other crucial metabolic functions. Bones contain 99% of the body’s calcium storage and may be broken down if calcium is needed for these bodily functions. Common sources of calcium include milk, yogurt, cheese, and fortified foods or juices. On average, men and women over 50 consume 600-700 mg of daily calcium in their diet. The initial approach to increasing daily calcium is through dietary intake, but supplements can help patients achieve the total daily recommendations. Taking supplements with food generally improves absorption. Calcium comes in two forms, calcium citrate and calcium carbonate. Calcium citrate is recommended over calcium carbonate as it has shown improved absorption and less GI upset.

Calcium intake of over 1,200 to 1,500 mg per day has little benefit and may increase the risk of cardiovascular events. However, some believe that the proposed risk of cardiovascular events due to increased vascular calcification is unproven and inaccurate. Recommended dietary intake includes at least 3 cups a day of a low fat dietary intake to meet daily calcium requirements. An additional 300-mg calcium supplement taken with food should be added for every serving missed. To optimize absorption, no more than 600 mg of calcium should be taken at one time. Calcium intake in excess of 600 mg in any single dose will pass unabsorbed through the gut. Calcium also requires gastric acidity for adequate absorption. Patients on acid suppressive therapy such as a proton-pump inhibitor may have decreased absorption. For these patients, the more acidic calcium citrate may be beneficial over calcium carbonate.

Several calculators are available online for patients to estimate their daily dietary calcium intake and determine how much supplementation is required.

Vitamin D, an important agent in calcium absorption, is taken in by dermal synthesis and in the diet. Vitamin D is a fat soluble vitamin which is found in foods such as fish, eggs, liver, and fortified milk. Inactive vitamin D is converted to an active form by enzymes in the liver and kidneys. Vitamin D binds to cellular receptors to activate response genes that increase absorption of calcium and improve bone mineralization. The intestines and skins ability to absorb vitamin D is diminished with aging. Elderly patients produce 75% less cutaneous vitamin D than young adults. Many Americans have low levels of vitamin D, particularly in northern latitudes with poor sun exposure. Renal failure patients have poor activation of Vitamin D in the kidneys which results in decrease calcium absorption.

A 25(OH) vitamin D blood test is used to tell if patients are getting enough in their diet. An optimal range for 25(OH) vitamin D is 30-55 ng/ml. Optimal calcium absorption occurs at a 25 (OH) D level of 32 ng/ml or higher. Vitamin D toxicity is rare and recent evidence has shown that daily intake over 2,000 IU is safe and beneficial for elderly patients trying to maintain adequate levels. Increasing vitamin D intake during the winter months may be beneficial to account for the lack of sunlight.

<table>
<thead>
<tr>
<th>Food</th>
<th>Calcium (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yogurt, low fat (6 oz)</td>
<td>300 mg</td>
</tr>
<tr>
<td>Greek yogurt (6 oz)</td>
<td>200 mg</td>
</tr>
<tr>
<td>Milk, low fat (8 oz)</td>
<td>300 mg</td>
</tr>
<tr>
<td>American Cheese (1 oz)</td>
<td>200 mg</td>
</tr>
<tr>
<td>Frozen Yogurt (8 oz)</td>
<td>100 mg</td>
</tr>
<tr>
<td>Fortified Juice (8 oz)</td>
<td>300 mg</td>
</tr>
<tr>
<td>Backed Beans (4 oz)</td>
<td>160 mg</td>
</tr>
<tr>
<td>Broccoli (8 oz)</td>
<td>200 mg</td>
</tr>
<tr>
<td>Soy beans (8 oz)</td>
<td>175 mg</td>
</tr>
<tr>
<td>Collard greens (8 oz)</td>
<td>360 mg</td>
</tr>
</tbody>
</table>

Table 2. Common Sources of Calcium

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exposure in patients living in northern latitudes. In northern latitudes up to 73% of the population may have moderately to severely deficient vitamin D levels of less than 20 ng/ml during the winter. Patients complaining of bone pain, myalgias, and generalized weakness may have hypovitaminosis D which may be missed without checking a Vitamin D level. Disorders that mimic hypovitaminosis D include fibromyalgia, chronic fatigue, and age-related weakness.

In practice, low vitamin D levels are very common especially among the elderly population. Vitamin D deficiency can cause a loss of bone density from decreased vitamin-D mediated calcium absorption. A low level of vitamin D leads to increased PTH secretion (secondary hyperparathyroidism) and as a result, an increase in bone resorption. Patients should try to achieve a target range of 50-70 ng/ml for both adequate bone health and muscle function. Two forms of vitamin D used in supplements includes D2 (ergocalciferol) and D3 (cholecalciferol). The two forms have equal efficacy in preventing and treating low vitamin D levels.

Vitamin D supplementation should be advised in all patients with 25 (OH)D levels below 30 ng/ml. Studies have shown a 20% decrease in hip and non-vertebral fractures among individuals aged 65-years of age and older who took at least 700-800 IU/day. In patients with moderate to severe hypovitaminosis D, or 25 (OH)D levels below 20 ng/ml, ergocalciferol 50,000 IU weekly for 6 weeks along with 2000 IU daily of vitamin D3 daily is frequently advised. At 12 weeks, the vitamin D and calcium levels can be re-assessed and the 50,000 IU discontinued if levels normalize. Patients should continue on 2000 IU daily as a maintenance dose once adequate levels are achieved. Ergocalciferol should be taken with food to maximize absorption. Ergocalciferol should not be used in patients with malabsorption syndromes. Vitamin D toxicity is rare and generally only occurs with doses greater than 10,000 IU/daily for prolonged periods. High levels of vitamin D can be associated with hypercalcemia, hyperphosphatemia, and hypercalciuria. Most clinical symptoms are associated with the resultant hypercalcemia and include nausea, dehydration, and constipation.

Medications
The World Health Organization (WHO) recommends treatment with a therapeutic agent in patients with a T score equal or below -2.5. FDA-approved medications should also be considered in patients over 50 years old who present with a vertebral or hip fracture and a T-score < -1.5. However, criteria for initiating a pharmacological agent can vary between institutions and providers. In a treatment algorithm proposed by Bouxsein et al, patients with a fracture of the appendicular skeleton (wrist, hip and humerus) and a T score > -1.5 should be recommended calcium and vitamin D and to monitor BMD scores annually. Patients with a T score < -1.5 and presenting with a fragility fracture should be started on a pharmacological agent.

Pharmacologic agents used to treat osteoporosis have been shown to significantly improve bone density and reduce the prevalence of fractures in patients at high risk. Medications that are currently available are divided into two classes: antiresorptive and anabolic agents. Antiresorptive agents work by preventing bone loss and anabolic agents increase bone formation. Current antiresorptive agents include bisphosphonates, calcitonin, estrogens, SERMs, and denosumab. Calcitonin, SERMs, and estrogens tend to have more potential side effects and less efficacy in preventing hip fractures. No data exists that shows either raloxifene or calcitonin reduces the risk of hip or vertebral fractures. Estrogen and hormonal therapy have been shown to have anti-fracture benefits but are used with caution as they may cause an increase

<table>
<thead>
<tr>
<th>Parathyroid hormone</th>
<th>Forteo (teriparatide)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANKL inhibitor</td>
<td>Prolia (denosumab)</td>
</tr>
<tr>
<td>Bisphosphonates</td>
<td>Fosamax (alendronate)</td>
</tr>
<tr>
<td></td>
<td>Fosamax Plus D (alendronate plus vitamin D)</td>
</tr>
<tr>
<td></td>
<td>Boniva (ibandronate)</td>
</tr>
<tr>
<td></td>
<td>Actonel (risedronate)</td>
</tr>
<tr>
<td></td>
<td>Actonel with Calcium Risendronate with 500 mg of calcium carbonate</td>
</tr>
<tr>
<td></td>
<td>Reclast (zoledronic acid)</td>
</tr>
<tr>
<td></td>
<td>Aredia (Pamidronate)</td>
</tr>
<tr>
<td>Calcitonin</td>
<td>Miacalcin or Fortical</td>
</tr>
<tr>
<td>Estrogens</td>
<td>Climara, Estrace, Estraderm, Estratab, Ogen, Ortho-Est, Premarin, Vivelle</td>
</tr>
<tr>
<td>Hormone Therapy</td>
<td>Activella, Femhr, Premphase, Prempro</td>
</tr>
<tr>
<td>Estrogen agonist/antagonist</td>
<td>Evista (raloxifene)</td>
</tr>
</tbody>
</table>
risk of cardiac and thromboembolic events. Bisphosphonates
Bisphosphonates are the most widely used medications to treat osteoporosis. In 2008, nearly 4 million women in the United States were taking a bisphosphonate. Currently bisphosphonates are offered in oral and intravenous infusion routes. Oral bisphosphonates include Fosamax, Boniva, and Actonel. IV bisphosphonates, such as Pamidronate, Reclast, and Boniva, may be used when oral agents cannot be tolerated.

Bisphosphonates inhibit osteoclast activity, and to a lesser degree, osteoblastic activity. Bisphosphonates adhere to hydroxyapatite and incorporate into bone matrix. This inhibits osteoclastic-resorption and can cause osteoclastic apoptosis. Markers for both bone resorption and formation have been shown to be suppressed during bisphosphonate use. Bone density is increased as osteoblastic activity outpaces osteoclastic activity while on bisphosphonates. Improvements in bone density while on these medications have been shown to reduce the risk of hip fracture by up to 50%. There are three generations of bisphosphonates with improved potency in progressive generations. Successive generations improve on inhibition of osteoclastic activity while decreasing inhibition of osteoblastic activity. Second generation bisphosphonates include pamidronate and alendronate and third generation includes risedronate and zoledronate. Retrospective analysis on fracture reduction for alendronate, risedronate, and ibandronate showed no significantly differences in efficacy between agents. However, risk of fracture was 12% lower in the alendronate users compared to ibandronate users.

Frequency of dosing of these agents may play an important role in patient compliance. For instance, monthly dosing with Boniva is a great option to help increase patient compliance over daily and weekly dosing. Patients are more compliant when the adverse reactions associated with oral bisphosphonates such as GI upset occur less often with less frequent dosing. Currently ibandronate 150 mg and risedronate 150 mg are the two monthly oral bisphosphonates available. Bone density increases the most over the first six months during bisphosphonate use as pits in bone caused by osteoclasts are filled in by osteoblasts. After the pits are filled very little new bone is formed and bone formation tapers off over 3 years. Patients taking bisphosphonates for over 6.5 years form very little bone and up to one third aren’t forming any new bone. A study in 2006 published in JAMA found no difference in non-vertebral fracture rates in patients who stopped taking alendronate after 5 years compared to those that continued. Most experts agree that continuing bisphosphonates beyond 5 years has little value and may actually increase the risk of a complication. For example, the risk of atypical fractures is found to be increased after 5 years of alendronate use. In one study, 77% of atypical fractures were found to have occurred after 5 years of bisphosphonate use. However, patients should be advised that atypical femur fractures are extremely rare with an estimated occurrence rate of 1 in 10,000 patients on a bisphosphonate.

However, there is some evidence that suggest a benefit of continued use beyond 5 years. The FLEX trial compared alendronate use in patients who stopped the medications after 5 years and those who continued through ten years. In the patients that continued, vertebral BMD increased nearly 4% and patients had less incidence of vertebral fracture. In 2011, The FDA issued a statement that a drug holiday or time period of stopping the medication may not be advisable in high risk patients. Even after the medication is stopped lasting bone effects remain. Bisphosphonates start to accumulate after 5 years of treatment and this storage causes lasting effects on bone long after the medication is stopped. If a drug holiday is considered BMD tests should be performed during the period and reinstituted if BMD shows a decline.

Patients taken oral agents are required to take the pill with a full glass of water and sit upright for 30-60 minutes after taking in order to improve medication absorption. Contraindications to bisphosphonates may include hypersensitivity and pre-existing hypocalcemia. If adverse events occur, such as GI upset, the bisphosphonate should be stopped and another agent considered.

Concern has been raised with bisphosphonate use in the setting of a fracture. Peter et al studied alendronate use in dogs during the period of fracture healing. The study found no difference in fracture union and strength between groups, but did show slower callus formation (delayed fracture remodeling) in the alendronate group. Additional studies have also shown similar delays in fracture healing with bisphosphonate use but ultimately no difference
in the end healing strength and mechanical integrity of the callus. With regards to bisphosphonate use in the setting of arthroplasty, animal models have shown no radiographic or histological concerns with fixation of implants. Osteonecrosis of the jaw (ONJ) is a common concern among patients considering starting antiresorptive therapy. ONJ is approximately 15 times more likely in patients on bisphosphonates compared to those who are not. Prior to starting therapy patients should have a recent dental exam and any necessary invasive dentistry performed. Patients already started on antiresorptive agents should let their dentist know prior to any dental procedures as invasive surgery such as tooth extraction or other oral bone surgery increases the risk of developing ONJ. Dentist may try to avoid or minimize boney exposure when considering surgery on patients taking antiresorptive therapy. ONJ is more common with IV administration, particularly in higher doses. The risk of ONJ also continues to increase with extended drug use; prevalence doubles after two years of use and is five times as likely after five years.

**Prolia (denosumab)**

Prolia (denosumab) is a RANK ligand inhibitor that works by inhibiting osteoclastic formation and activity. Prolia is given in a single dose 1 ml subcutaneous injection every 6 months. Potency of osteoclastic inhibition peaks during the first month after the injection and gradually declines over a 6 month period. At 6 months, the injection should be repeated to resume efficacy. As a result of increased osteoclastic inhibition during the first month of use patients may experience hypocalcemia during this period. This is a result of inhibited osteoclasts losing the ability to break down bone and release calcium into the blood stream when stimulated by parathyroid hormone. The biggest risk of hypocalcemia seems to be around the 10-day post injection mark. This period may be accompanied by a surge in parathyroid hormone as the body responds to osteoclastic inhibition and hypocalcemia. Calcium levels should be checked prior to using Prolia and adequate supplementation should be advised in order to prevent hypocalcemia during treatment. Patients with low 25 (OH) D levels (below 15 ng/ml) should be advised to correct their levels prior to starting Prolia. Significantly low vitamin D levels may limit calcium absorption and exacerbate hypocalcemia episodes.

Brown et al performed a double blinded study comparing denosumab and a commonly used bisphosphonate alendronate in postmenopausal women. The study found that Prolia produced significantly greater gains in BMD at all measured skeletal sites compared to alendronate. The safety profiles, including the reported frequency and pattern of adverse events, were similar between groups.

**Forteo (teriparatide)**

Forteo is a hormone parathyroid recombinant and the only anabolic agent available to treat osteoporosis. Forteo is administered as a daily 20 mcg subcutaneous injection. Use is restricted to a total lifetime use of 24 months; this may include a treatment period of 24 consecutive months or shorter periods of treatment added together over a patient’s lifetime. Forteo should not be used in patients at a baseline risk for osteosarcoma such as Paget’s disease, unexplained increased alkaline phosphatase, open physis, a history of skeletal malignancy, and a history of prior skeletal radiation therapy. Forteo is also contra-indicated or used with caution in patients with metabolic bone disease, hypercalcemia, urolithiasis, as well as patients with hepatic, renal, and kidney disease.

An increase in parathyroid hormone may result in a hypercalcemic state secondary to increased calcium absorption by the kidneys and intestines. For this reason, Forteo is contra-indicated in patients with pre-existing hypercalcemia as the condition may worsen with treatment. Symptoms of hypercalcemia may include muscle weakness, fatigue, nausea, vomiting, constipation, depression, and arrhythmias. Prolonged hypercalcemic states may result in conditions such as pseudogout, gastric ulcers, kidney stones, and cardiac disease. Although prolonged hypercalcemic states are rare with Forteo use, patients should still track daily calcium intake to avoid excessive absorption.

In order to understand the pharmacokinetics of Forteo one must understand the role of parathyroid hormone in the body. The parathyroid gland secretes parathyroid hormone in response to changes in serum calcium levels. A rise in serum calcium acts as a negative feedback loop to reduce PTH secretion. PTH acts directly on the kidneys to increase resorption of calcium and to increase excretion of phosphorus. PTH also increases conversion of 25 OH vitamin D
to 1,25 OH vitamin D (calcitriol) which in turn stimulates intestinal absorption of calcium and phosphorus. PTH increases bone resorption and activates osteoclastic activity when secreted in a continuous fashion. Hyperparathyroid patients who have a sustained elevation in PTH levels over time have an increased risk of osteoporosis due to this sustained elevation in osteoclastic activity. Conversely, when PTH is secreted intermittently osteoblastic activity is stimulated to a greater degree than osteoclastic activity. Daily doses of Forteo provide this type of intermittent effect. This is due to the drugs short half life; Forteo reaches a peak serum concentration in 30 minutes and declines to non-detectable levels in 3 hours. This is how Forteo builds bone as osteoblastic activity outpaces osteoclastic activity. By stimulating remodeling, Forteo makes bone mechanically stronger by increasing mass and new bone formation. This process has been shown to increase bone strength over antiresorptive agents. Body et al found that Forteo increased bone density of the vertebral spine (measured by DXA) over two times more than alendronate after one year with increases of 12.2% and 5.6%, respectively. 16 While on Forteo, BMD increases to a greater extent in metabolically active trabecular bone such as the lumbar spine compared to cortical bone of the hip and wrist. Bone strength doesn’t necessarily correlate with bone density, however. New bone that is created while on Forteo contains less mineral content but overall the bone is actually stronger due to an overall net gain in formation. In some cases hip BMD scores will be reduced while on Forteo but bone quality and strength is actually improved.

Forteo has also been shown to accelerate healing in elderly patients with osteoporosis and pelvic fractures. Peichl et al found earlier healing on CT scan of pelvic fractures treated with PTH compared to no treatment. Average time to cortical bridging was 7.8 weeks and 12.6 weeks, respectively. 14 Forteo has also been shown to improve healing rates in atypical femur fractures caused by bisphosphonates. 22

An additive affect has been hypothesized with combination treatment of a bisphosphonate and teriparatide therapy. However, studies have shown that the combination offers no additional benefit over monotherapy and bisphosphonates may even impair the ability of PTH to increase bone density. Therefore, concurrent dual therapy is currently not recommended. Starting a bisphosphonate or denosumab after stopping teriparatide use appears to help maintain gains in bone mineral density. 22

**Barriers to Treatment**

Advanced age is often a barrier to treatment as many providers question the benefits of a pharmacological agent in the elderly population. Furthermore, few efficacy studies on osteoporosis medications have included participants over the age of 80 years old. Many providers falsely believe that the potential for side effects may outweigh the benefits of treating elderly patients. However, the elderly population is at the greatest risk of falling and therefore benefit substantially from therapeutic treatments. An estimated 60% of all hip fractures in women occur over the age of 80. 33

Another barrier to treatment occurs when patients present with a DXA score in the osteopenic range (T score -1.0 to -2.5) in the presence of a fragility fracture. An important point to consider is that most patients who sustain a fragility fracture have a T score in the osteopenic range. Patients with DXA scores in the osteopenic range with a history of a fragility fracture have osteoporosis by many national guidelines and should be treated.

Many patients with osteoporosis are already taking several medications and are often apprehensive about starting another. Compliance to oral medications is an estimated 50% after the first year. IV Reclast or subcutaneous Prolia are nice options in these patients. Teriparatide requires daily injections so clinicians must spend the necessary time educating patients on the benefits of an anabolic agent in order for them to feel comfortable with routine self administration.

**Monitoring Treatment**

Serial BMD testing helps monitor treatment by showing changes in bone density over time. Testing is generally done two years after initiating treatment. 6 The National Osteoporosis Foundation and Medicare guidelines recommend repeat BMD studies every two years. Conditions like steroid use that cause rapid bone loss should have more frequent follow-up. Drawing repeat serum NTX or urine CTX levels at 6 to 12 month intervals and comparing to baseline levels is often done to help monitor therapeutic response as well.
PQRS Osteoporosis Measures

The physician quality reporting system (PQRS) was established by the Center for Medicaid and Medicare Services (CMS) to help improve the quality of care for program recipients in the outpatient setting. Reporting osteoporosis in patients who have sustained a fragility fracture helps increase awareness for screening and treatment. The number of people who are 65 years of age and older will dramatically increase in the near future. Prevention and treatment of osteoporosis in this at risk group will prevent fractures and help save millions of dollars in healthcare costs.

Physicians, advanced practitioners, and therapists must report osteoporosis measures in all patients under the Medicare Part B Physician Fee Schedule. In an orthopedic setting, this will generally be done in a qualified electronic health record (EHR). CMS will penalize all practitioners 1.5% in 2015 and 2% in 2016 of all covered services provided to Medicare beneficiaries if the measures aren’t documented.

Certain measures will be specific to an orthopedic setting including documentation and management in men and women over 50-years old who have sustained a hip, spine, or distal radius fracture. PQRS measure #24 requires documentation by the physician managing the patient’s ongoing post-fracture care that a fracture occurred and that the patient was or should be tested or treated for osteoporosis. PQRS measure #40 requires documentation that patients who have sustained a hip, spine, or distal radius fracture have had a central DXA ordered or performed or pharmacological therapy prescribed. PQRS measures #154 and #155 state that patients over 65-years old with a history of falls are required to have a fall risk assessment and plan of care for prevention documented. The PQRS requirements are a huge step in improving the diagnosis and treatment of osteoporosis. Medicaid and Medicare spend billions of dollars annually on surgical treatment for fragility fractures. Preventing these fractures reduces healthcare costs and improves the health of our patients. It is time orthopedic providers step up and join the fight against osteoporosis.

References
17. Lane JM, Lin JT. Advances in Therapeutics and Diganostics: Bisphosphonates. JAASOS. 2013; 11-1.
31. Licata A. Bone density vs. Bone quality: What’s a clinician to do?
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Exertional heat illness (EHI) encompasses heat cramps, heat syncope, heat exhaustion and exertional heat stroke (EHS). EHI occurs in 1.20 of 100,000 athlete exposures. Football has a far higher incidence with 4.42 per 100,000 athlete exposures. The purpose of this practice brief is to define current recommendations for return to play following an episode of EHI. Heat cramps, characterized by acute, painful involuntary muscle contractions during or as a result of intense exercise, are not life-threatening. Heat syncope is caused by a lack of adequate blood flow to the brain, resulting in orthostatic dizziness and fainting. Heat exhaustion is characterized as the inability to continue exercise due to a combination of factors including heavy sweating, dehydration and electrolyte imbalances. This is also not a life-threatening condition, as the athlete’s core body temperature does not reach a level high enough to have multi-organ effects. Exertional heat stroke (EHS), characterized by a rectal temperature greater than 40° C (104° F) with changes in CNS function, is a life-threatening condition if proper treatment is not provided within 15-30 minutes.

Current research demonstrates a lack of a consistent, evidence based protocol for return to play following EHI. One of the most difficult aspects in developing this protocol is the lack of true measures to determine when an athlete has reached a final recovery point, particularly in patients that experience post EHS sequela. At this point in time, experts in heat and hydration have developed a common sense based recommendation for athletes returning to sports post EHI. The protocol to return to sports is dependent upon which EHI condition the patient experiences and severity. Table 1 outlines the current recommendations based on condition. Return to play should be considered on a case-by-case basis, as there are multiple factors that play a role in the athlete’s ability to participate. In addition to following the current recommendations, a provider must implement measures to reduce the risk of reoccurrence by addressing common risk factors and the contributing factors to the individual’s incident. These common risk factors include high body weight, lack of heat acclimatization, low fitness capacity and low fitness level, high intensity exercise, inadequate work to rest ratios, dehydration and the first 5-7 days for the training season.

Many EHIs can result in collapse. In any athlete who collapses during intense exercise, cardiac emergencies should be ruled out immediately followed by subsequent differential diagnoses.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Heat Cramps</th>
</tr>
</thead>
</table>
| Definition/ Diagnostic Criteria | • Acute, painful involuntary muscle contraction during or after intense exercise  
• Proposed causes include dehydration, electrolyte imbalance and muscular fatigue  
• Important to differentiate between the sensation of “cramping” that is reported in exertional sickling cases, however, this cramping will not result in visible muscle spasms. |
| Return to Play Considerations | • Must replace electrolytes and water lost in sweat or rest if high exercise intensity or load is the causative factor  
• May return to play same day with replacement or rest if this is the determined cause |
Table 1: Diagnosis and Standards of Practice for Return to Play Following Exertional Heat Illness

<table>
<thead>
<tr>
<th>Condition</th>
<th>Heat Syncope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition/Diagnostic Criteria</td>
<td>• Orthostatic dizziness due to lack of blood flow to the brain.</td>
</tr>
<tr>
<td></td>
<td>• Signs and symptoms: Dizziness, loss of consciousness, weakness, tunnel vision, decreased HR, pale skin, which usually resolves quickly (&lt;5 minutes) with fluid replacement, rest and by laying supine with legs elevated to improve blood re-distribution</td>
</tr>
<tr>
<td></td>
<td>• Hard to distinguish between exertional heat stroke as both usually result in collapse and should consider core temperature measurement to differentiate if improvement is not seen within 5 minutes</td>
</tr>
<tr>
<td>Return to Play Considerations</td>
<td>• Athlete should seek clearance by physician prior to return to play</td>
</tr>
<tr>
<td></td>
<td>• Remain out of activity until adequately rehydrated based upon urine color and asymptomatic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Exertional Heat Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition/Diagnostic Criteria</td>
<td>• Overload of the thermoregulatory system that is life threatening if not recognized and aggressively treated with onsite whole body cold-water immersion within 15-30 minutes.</td>
</tr>
<tr>
<td></td>
<td>• Signs and symptoms: rectal temperature above 40° C (104° F) with change in CNS function (i.e. confusion, dizziness, disorientation, combativeness, nausea, vomiting, fainting, and in a few cases seizures or loss of consciousness). Rectal temperature is the only valid device for temperature assessment in EHS patients and invalid devices should not be used in its absence.</td>
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<td>Return to Play Considerations</td>
<td>• Removal from physical activity for a minimum of 7 days.</td>
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<td>• Must be asymptomatic with normal blood markers for organ function and muscle damage (renal and hepatic panels, electrolytes, muscle enzyme levels) and cleared by physician</td>
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<td>• Following 7 days of rest and physician clearance, begin exercise in cool environment and increase duration and intensity followed by a similar progression done in a warm environment, usually over the course of 3-5 weeks depending on the athlete’s response and amount of total rest taken prior to return to activity (more time is required if more rest is taken to account for loss of fitness and severity of EHS).</td>
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<td>• Consider performing a heat tolerance test if the athlete struggles to progress in exercise sessions or if sequela are present.</td>
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<td>• If patient continues to be heat intolerant, consider consulting with team physician and EHS experts to determine best course of action and ability to return to play.</td>
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References