Module 1 Reading: BFX and CFX Implants

The **Universal Hip System** is a comprehensive set of implants and instruments designed to address the diversity of patients and disease conditions that present to you for total hip replacement (THR). The implants include a standard product line that addresses approximately 80% of patients, and a special product line that addresses the remaining 20% of patients. In a small percent of cases, a patient may have unique requirements that are not met by the standard or special product lines. In these cases, you may be able to order a custom manufactured implant (Fig 1-1).

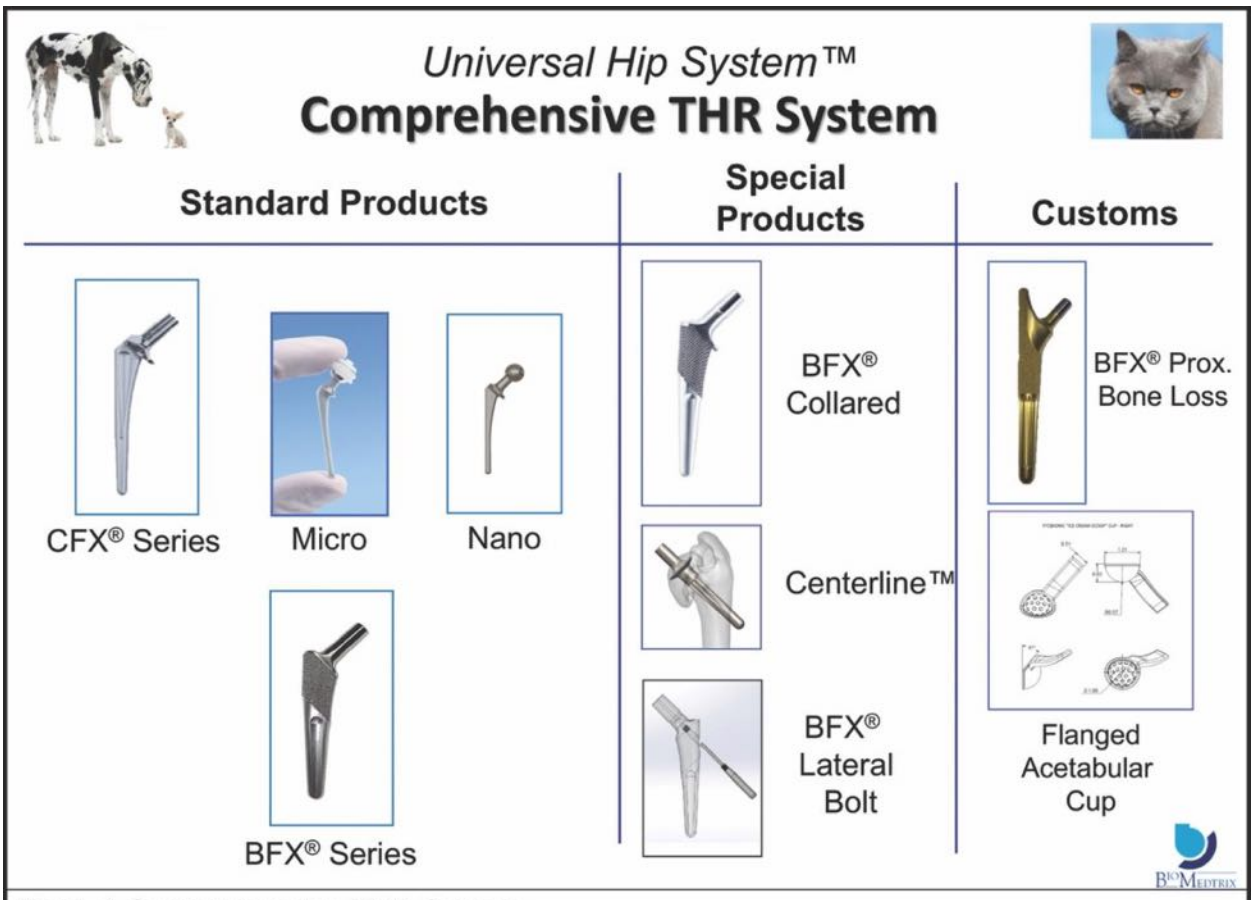


Fig 1-1 Comprehensive THR System

The system is comprised of the **CFX series** of implants for cemented fixation and the **BFX series** of implants for biological fixation. The Universal Hip System gives you the ability to cement both implant components using the CFX components or to utilize biological fixation for both the cup and the stem with the BFX components. Alternatively, because of the common femoral head diameters, you are able to combine CFX and BFX components in the same patient (Fig 1-2). It is possible to have a CFX component on one side of the joint and a press-fit or BFX component on the other side of the joint. This is referred to as **hybrid fixation** (Fig 1-3). There

are patients that are best managed with a CFX stem and a BFX cup. In some of the larger breeds including Great Danes and often German Shepherds, the size or shape of the proximal aspect of the femur or the quality of the bone may not be adequate to support a BFX press-fit stem. In those cases, the more appropriate option may be hybrid fixation with a cemented stem and press-fit cup. The combination of a press-fit cup with a cemented stem is the most commonly used form of hybrid fixation. Rarely is a CFX cup and a BFX stem indicated. Generally speaking, if a CFX cup can be placed, a BFX cup can also be placed and is preferred for a variety of reasons.

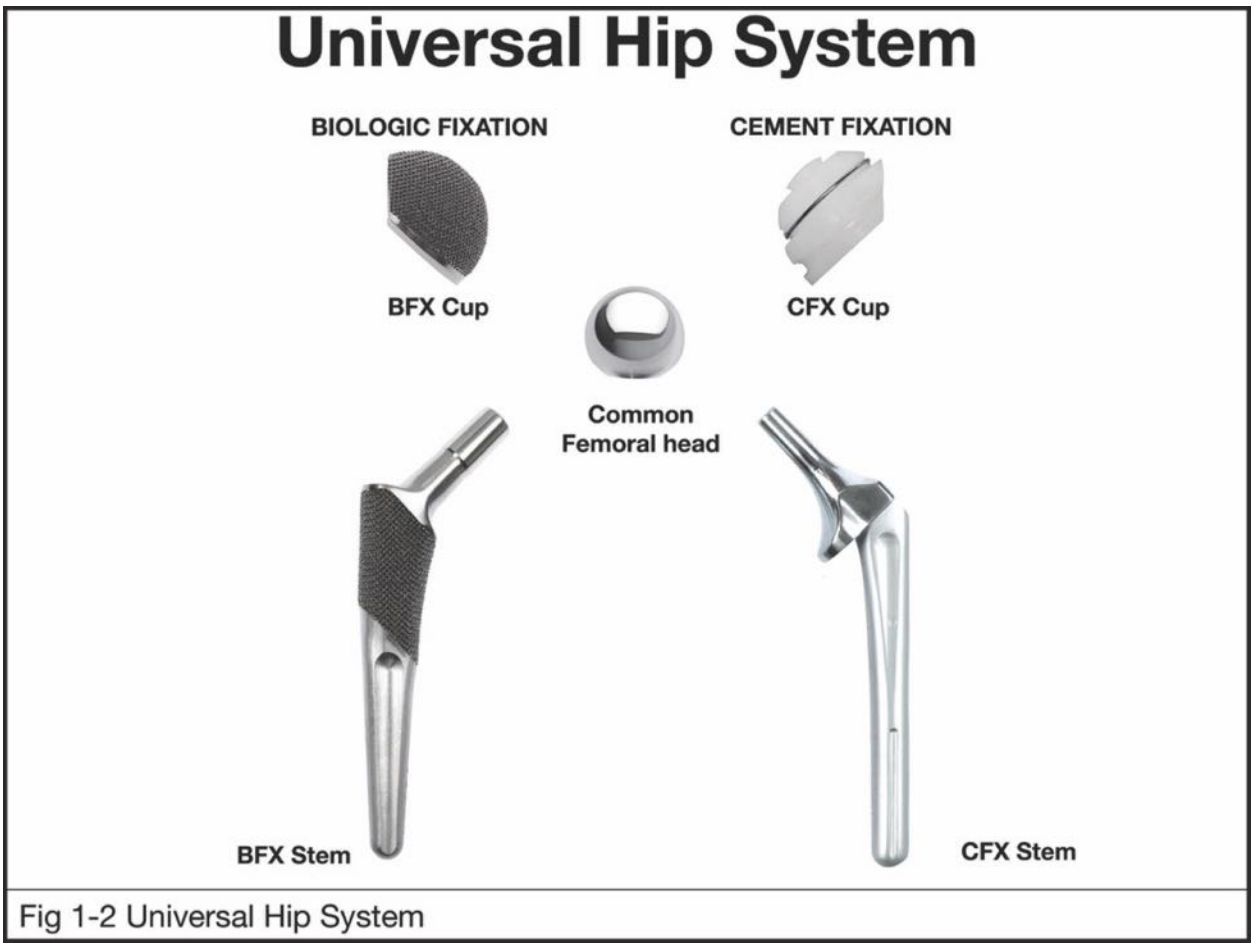


Fig 1-2 Universal Hip System

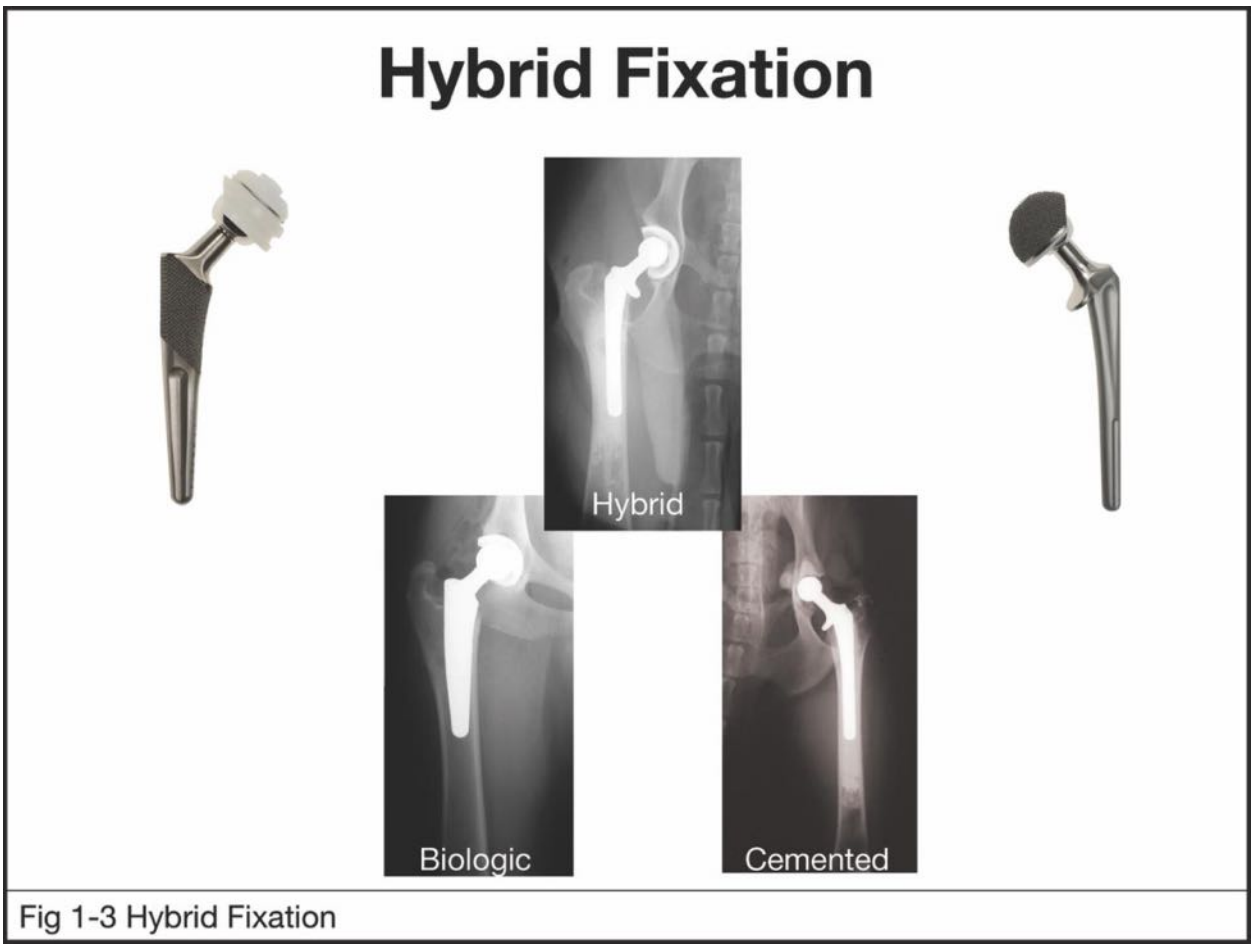


Fig 1-3 Hybrid Fixation

The CFX cemented implants include eight (8) cobalt chrome femoral stems, and eight (8) all polyethylene acetabular cup sizes. The femoral heads are available in different diameters to match the various inside diameters of the all-polyethylene CFX cups as well as the metal backed BFX cups. The different diameter head sizes were created in order to maintain minimum required cup wall thicknesses for polyethylene wear. The femoral heads are available in 12, 13, 14, 17 and 22 mm diameter with each head diameter having multiple neck length choices (Fig 1-4).

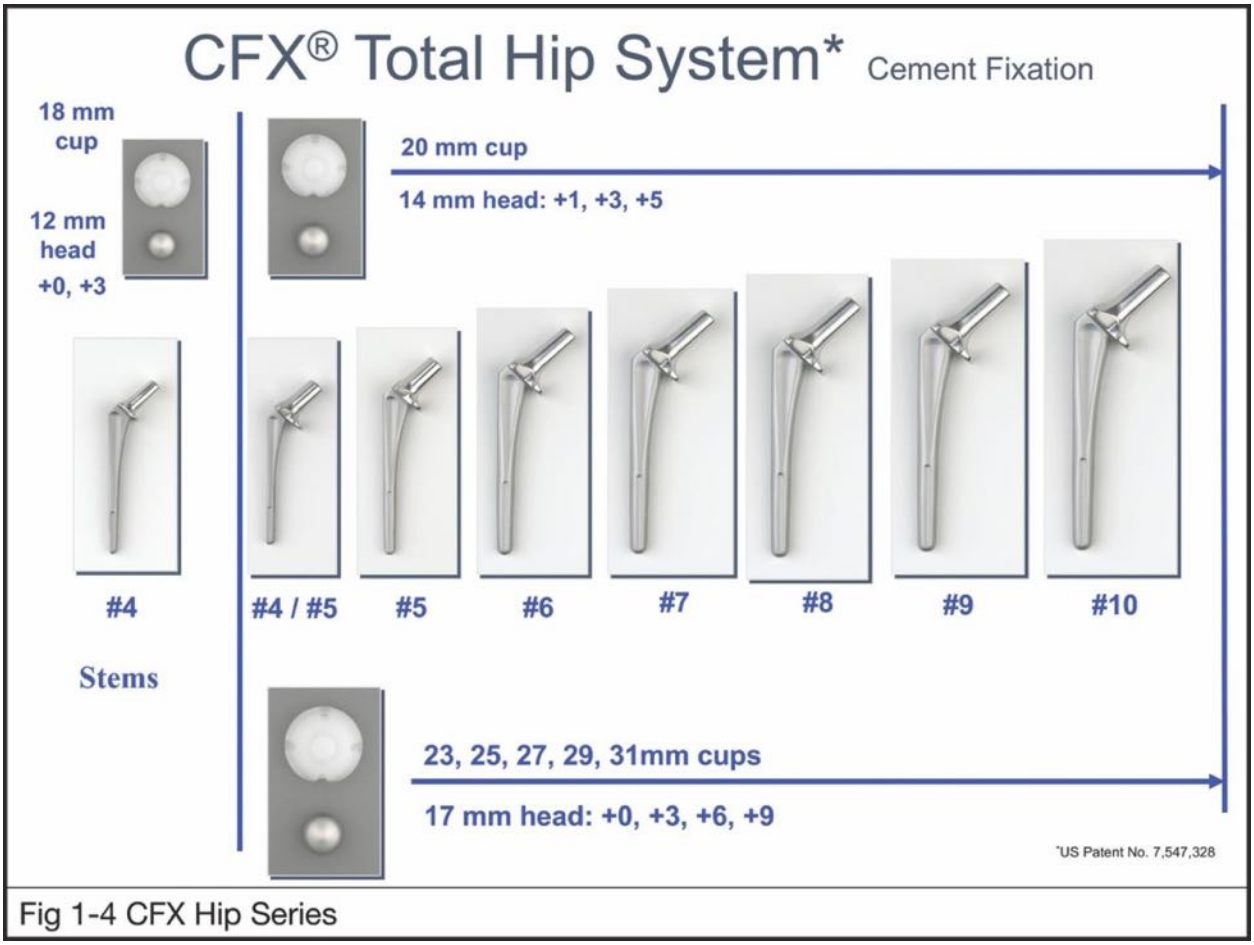


Fig 1-4 CFX Hip Series

The BFX stems include nine (9) titanium femoral stem sizes. These implants have a 3-dimensional porous surface surrounding the proximal portion of the stem. The porous portion of the stem is press-fit into the femoral preparation to provide initial stability of the implant during the immediate postoperative period. During the first 4-8 weeks following surgery, bone grows into the porous surface resulting in long-term fixation of the stem. There are eight (8) BFX polyethylene acetabular cup sizes each backed with a metal titanium shell. The outer surface of the titanium shell has the same 3-dimensional porous surface for bone ingrowth. For initial stability, the cup is press-fit into the acetabular bed preparation. These implants are coupled together with the same femoral heads used with the CFX Series of implants (Fig 1-5).

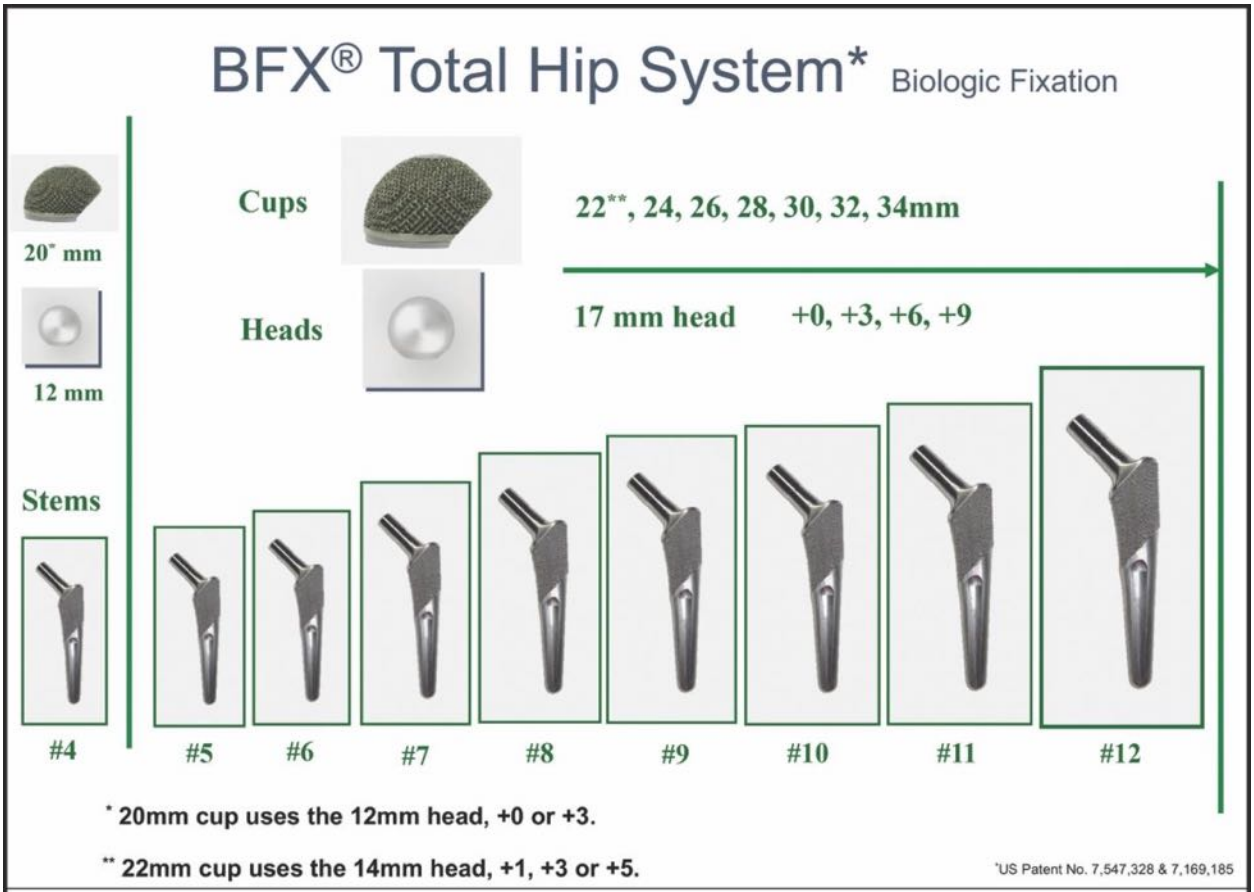


Fig 1-5 BFX Hip Series

The CFX implants utilize bone cement to provide the initial and the long-term fixation of the implants. The **Veterinary Bone Cement** (Fig 1-6) has a powder and a liquid component that are mixed during the procedure and injected into the femoral and acetabular bone preparations with the aid of a **Cement Gun** (Fig 1-7). Before injecting cement into the femoral canal, a polyethylene **Cement Plug** (Fig 1-8) is inserted into the canal to allow cement pressurization during stem insertion, thereby forcing the liquid cement into the trabecular bone for a secure interlock. A **CFX Stem Centralizer** (Fig 1-9) is placed onto the stem tip to prevent the tip from contacting the bone and to maintain the integrity of the cement mantle distally around the stem tip.

Veterinary Bone Cement

Fig 1-6 Veterinary Bone Cement

Fig 1-7 Cement Gun

Fig 1-8 Cement Plugs

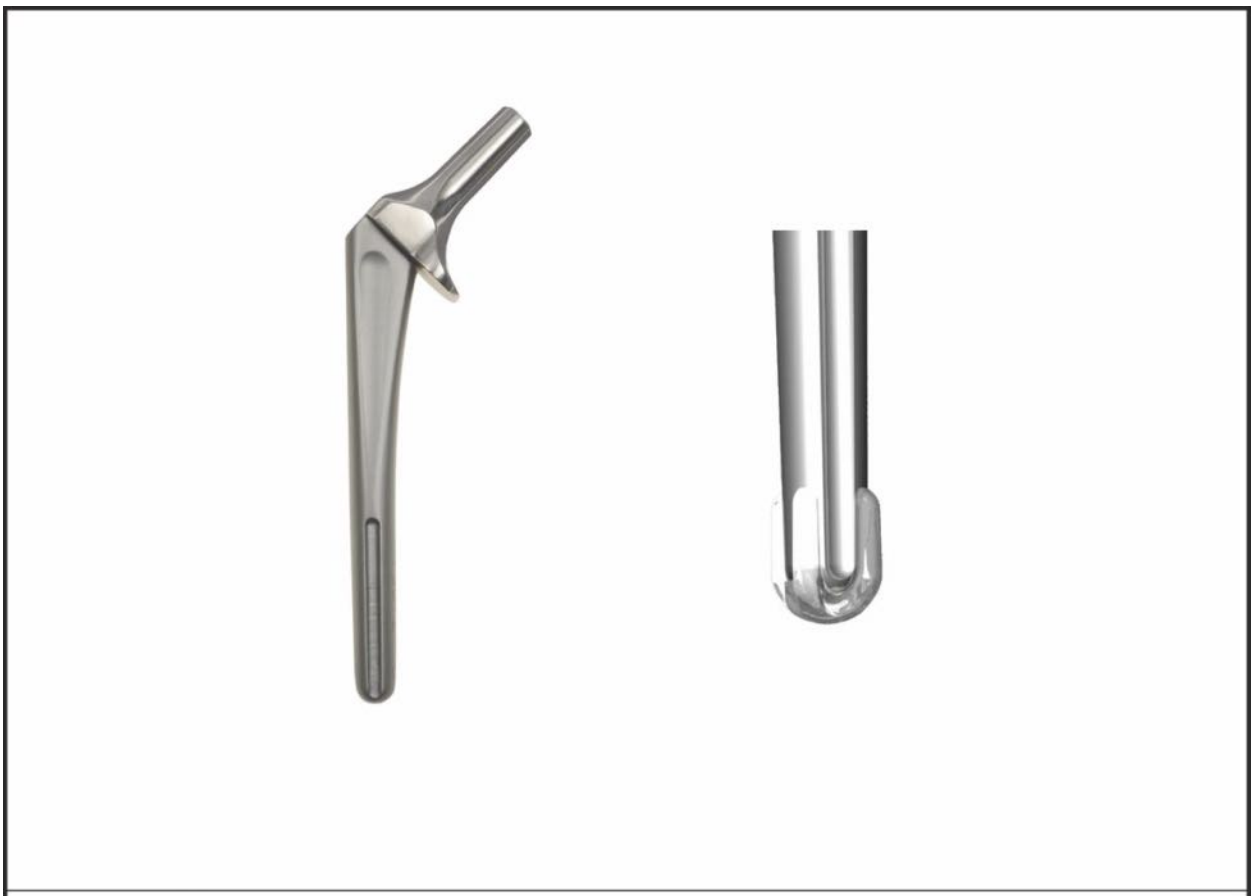


Fig 1-9 CFX Stem Centralizer

At this point, it is not necessary to memorize all the various size cups and stems or the multiple head diameters and which heads work with which stem. Unless you are performing this surgery with regular frequency and learn all the nuances, it is best to consult the **THR Implant Selection Chart** (Fig 1-10).

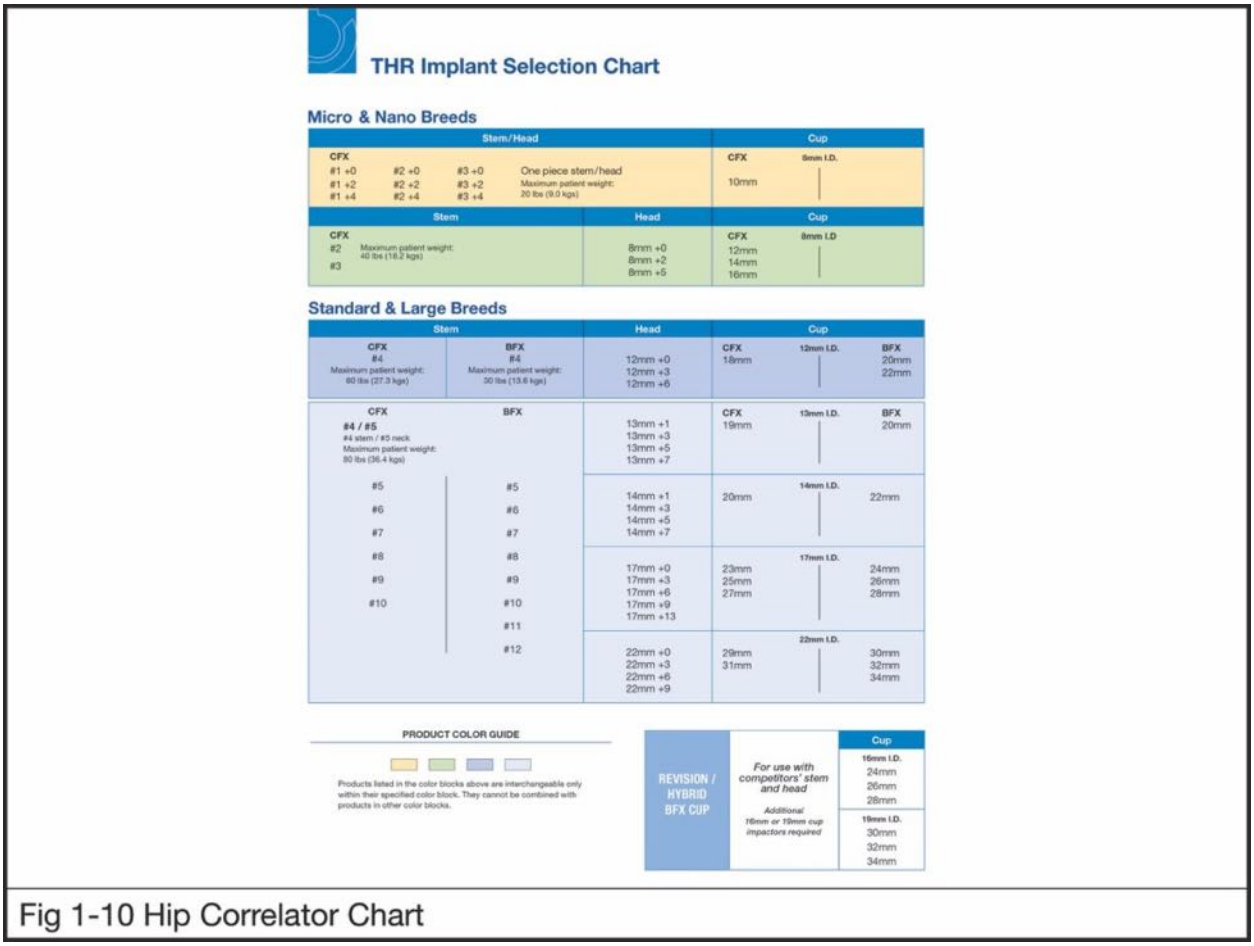


Fig 1-10 Hip Correlator Chart

In patients where additional stability for a press-fit, femoral stem is required, specialty stems like the **BFX Lateral Bolt Femoral Stem** (Fig 1-11) or the **BFX Collared Femoral Stem** (Fig 1-12) can be used to augment the initial fixation. This decision is based on the patient's bone morphology and bone quality as well as surgeon preference and level of experience press-fitting femoral stems.

Fig 1-11 BFX Lateral Bolt Stem

Fig 1-12 BFX Collared Stem

In addition to the standard implants, several specialty products are available on request for use in selected cases:

1. **Large Breed Expanded Size BFX Cups:** An expansion upon the available sizes of the Universal Hip Large Breed BFX Cups. The expanded sizes include 36, 38, 40, and 41 mm O.D. (22 mm I.D.) BFX Cups. The additional instruments are available as a Loaner Instrument Set.

2. **Large Breed Expanded Size BFX Femoral Stem # 13:** The #13 BFX Femoral Stem is available in both Collared and Lateral Bolt configurations. The #13 Femoral Stem requires size-specific instruments available for purchase or loan from BioMedtrix.

3. **Universal Hip Antimicrobial Implants:** These BFX Cups, BFX Lateral Bolt Stems, and Lateral Bolts are coated with an antimicrobial coating that provides a continuous release of silver ions to inhibit the growth of bacteria on the surface of the implant for at least

100 days after surgery. These implants are intended for use in cases where a risk of infection may be a concern.

4. **KYON Revision BFX Cups:** These BFX Cups are available in 24, 26, and 28 mm O.D. (16 mm I.D.) and 30, 32, and 34 mm O.D. (19 mm I.D.). They are compatible with the KYON Zürich Cementless THR standard Femoral Head for a combination BioMedtrix/KYON solution.

5. **Universal Hip Poly-XVE BFX Cups and Revision Liners:** The full range of BFX Cups for Standard and Large Breeds are available with an alternate Poly-XVE liner. These radiation cross-linked liners are vitamin E-diffused, ultra-high molecular weight polyethylene (UHMWPE) are available to retard oxidation and improve the wear-resistance of the bearing surface. Poly-XVE Revision Liners are available for replacing a damaged or worn liner in a previously implanted BFX Cup.

Module 2 Reading: Universal Hip Instrumentation

The Universal Hip System Instrumentation consists of four (5) separate instrument sets accommodating the following implant preparations (Fig 2-1):

Micro & Nano Hip Instrument Set: Contains the instrumentation to prepare the femur for stem sizes 1, 2, and 3 and the acetabulum for cup sizes 10, 12, 14, and 16 mm for cement preparations. These implants are designed for small size dog breeds and cats. The technique is taught in a separate course.

Basic Preparation Instrument Set: Contains the instrumentation to prepare the femur for stem sizes 4–10, and the acetabulum for cup sizes 18–28 mm cups for standard size dog breeds.

CFX Preparation Supplement Instrument Set: Contains the additional instruments needed to cement CFX stem sizes 4-10.

Large Breed Supplement Instrument Set: Contains the additional instruments required to prepare the femur for stem sizes 11-12 and the acetabulum for cup sizes 29–34 mm for large dog breeds.

Lateral Bolt Supplement Set: Contains the additional instruments to implant the Lateral Bolt Stem. The use of this instrumentation will be presented in Module 11.

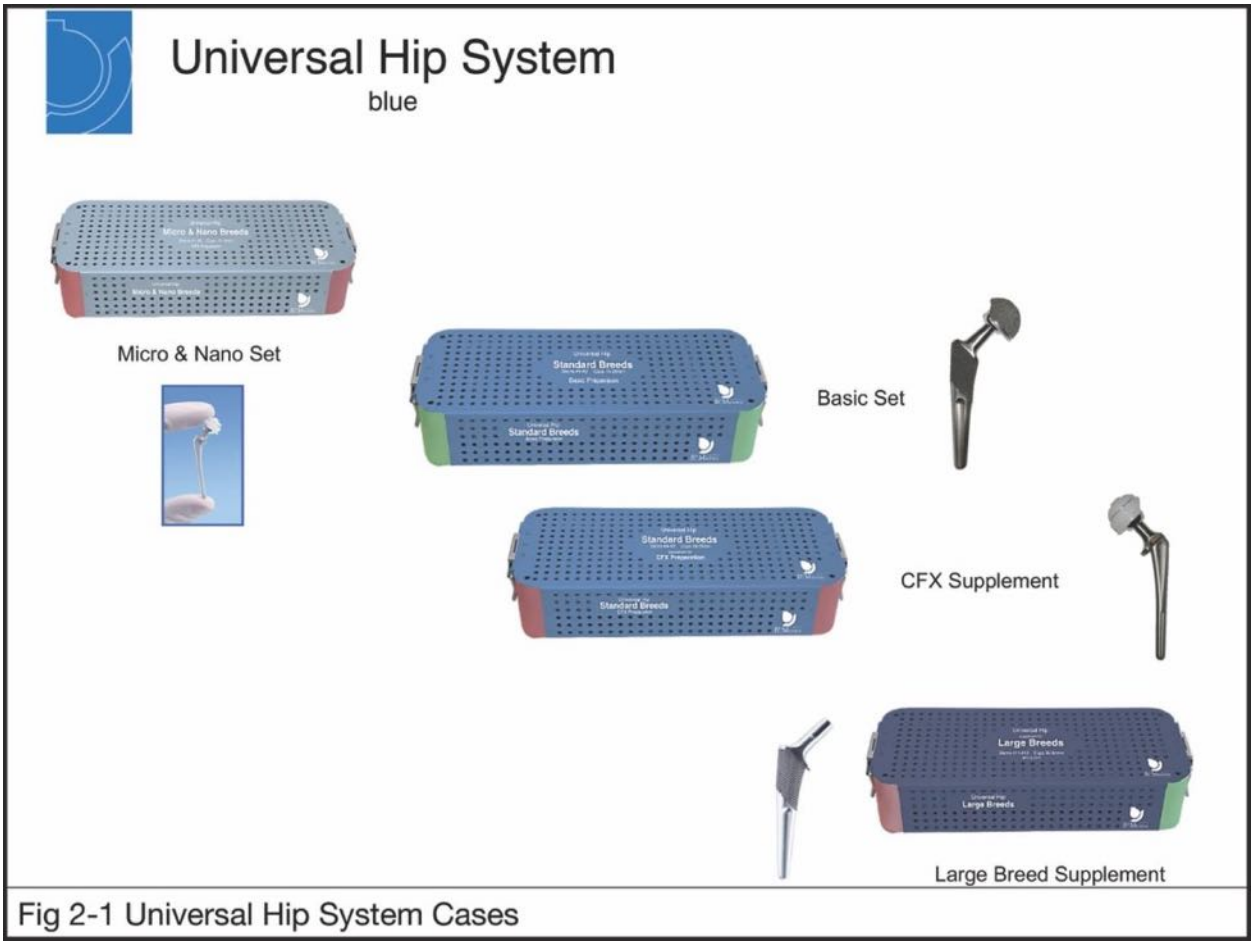


Fig 2-1 Universal Hip System Cases

The hip instruments are designed to create accurate femoral and acetabular bone preparations that will provide a stable press-fit for the BFX implants. The same preparations allow adequate space for a mantle of bone cement for CFX implants. The CFX cup or stem is downsized one or two sizes from the final BFX preparation to allow for the cement mantle. Each instrument set contains the instruments necessary to prepare the bone and to insert the implants.

The Universal Hip System instrument sets and their matching implant packaging are color-coded for visual identification and verification that the implant and instrument set match. For the Universal Hip System, the color is blue with additional secondary colors differentiating the implant series (Fig 2-2).

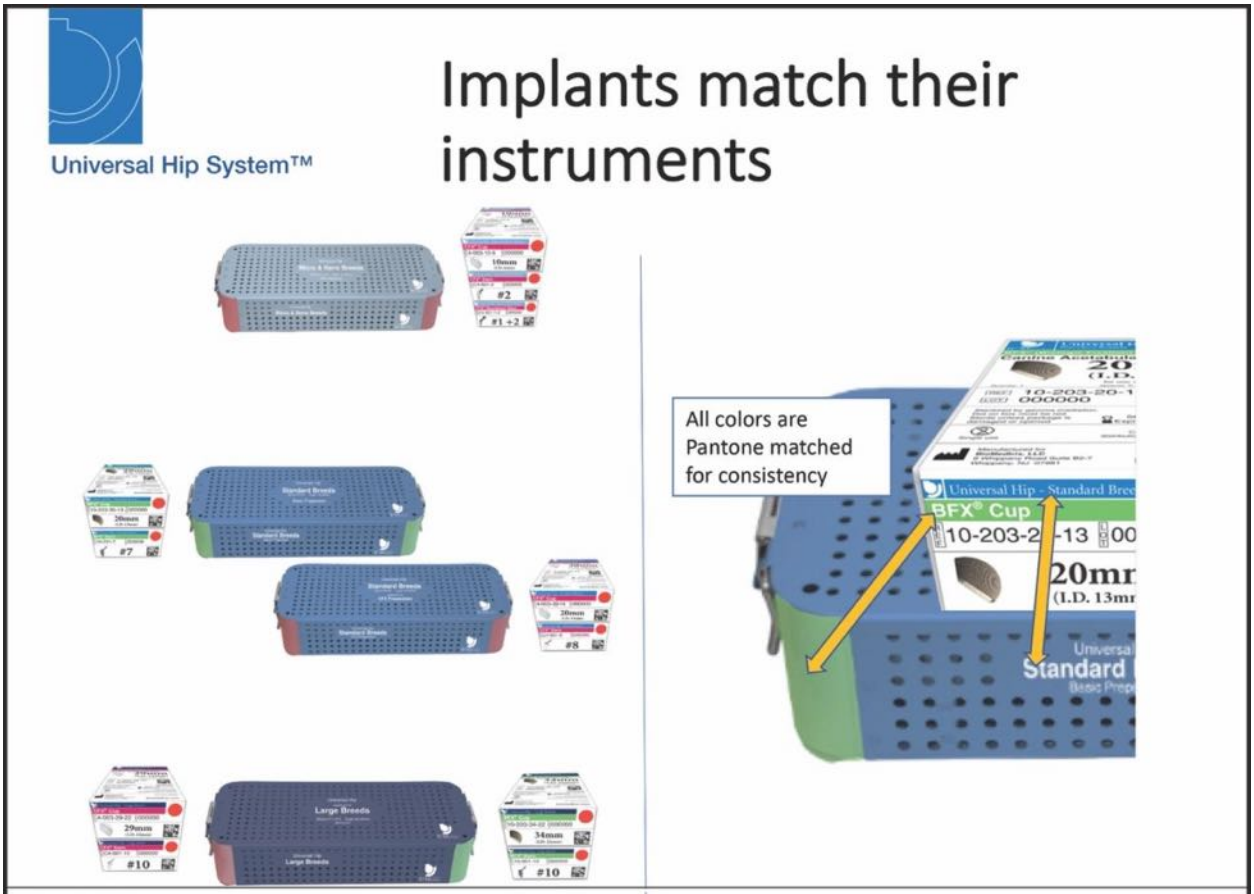


Fig 2-2 Implants Match Instrument Sets

An **X-Ray Magnification Indicator** is available to aid you in determining the percent magnification of the proximal aspect of the femur and the acetabulum on preoperative radiographs (Fig 2-3). It is essential to know the percent magnification to select the appropriate acetabular and femoral templates to estimate the proper size implant required for the patient.

X-Ray Magnification Indicator

Fig 2-3 Xray Magnification Indicator

The total hip replacement procedure begins by securely positioning the patient using the **Positioning Board** (Fig 2-4). If you choose not to use this device, the alternative is to use a surgical beanbag positioner. The advantage of the **Positioning Board** is that the **Positioning Board Alignment Guide** rests on the top of the **Positioning Board Posts,** providing visual guidance for reaming and cup insertion.

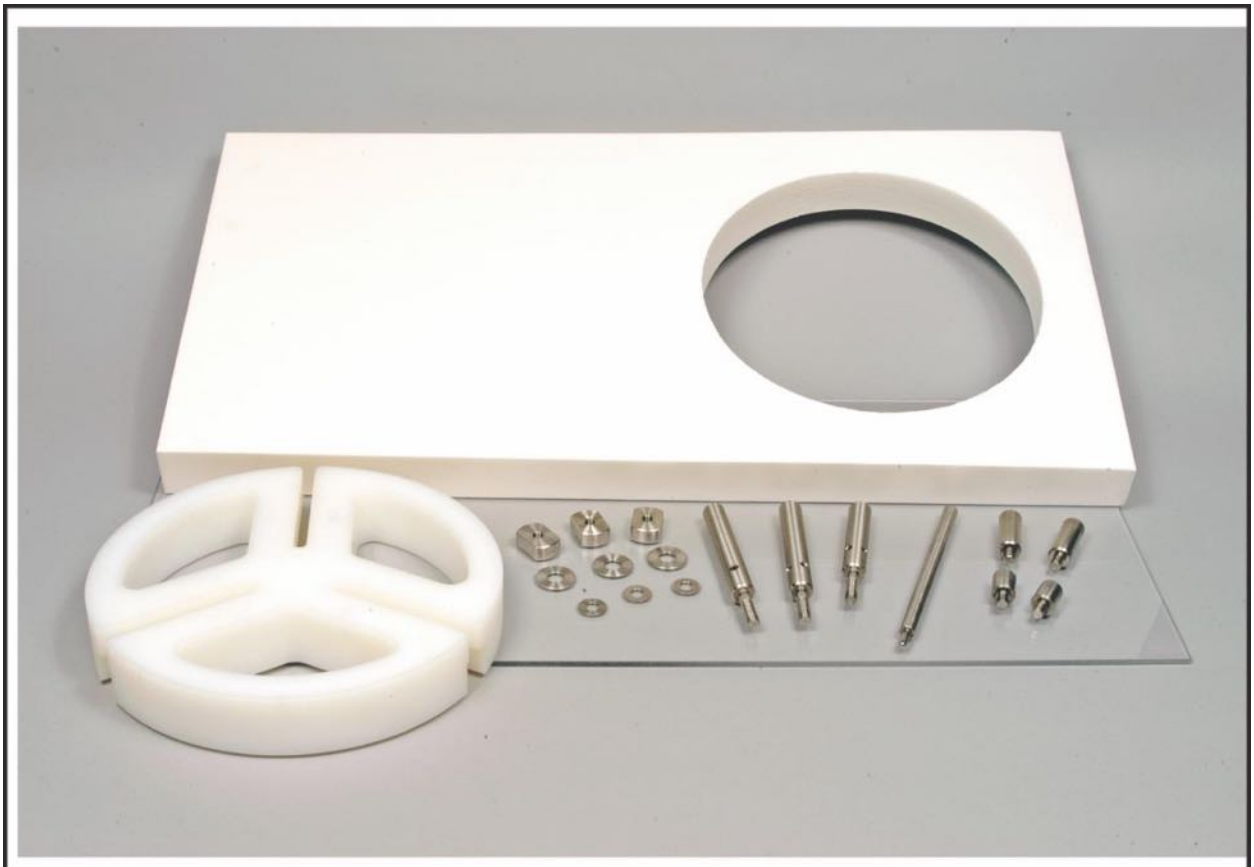


Fig 2-4 Positioning Board

The first step in the surgical procedure is making the femoral neck osteotomy. There are two (2) instrument options for this surgical step: The **Neck Resection Template** or **Neck Resection Guide** (Fig 2-5). As with the positioning devices, the choice of resection guide is a personal preference.

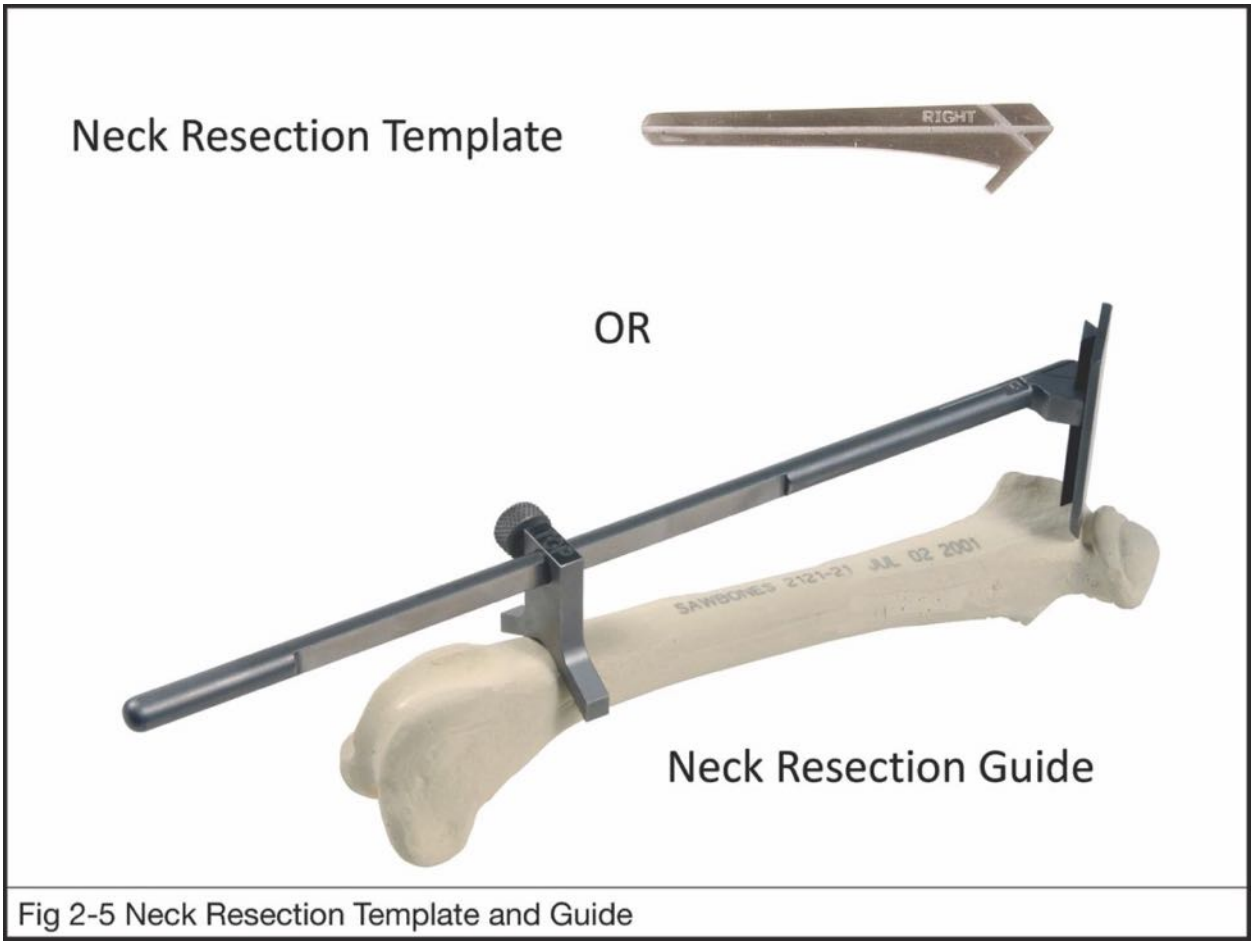


Fig 2-5 Neck Resection Template and Guide

Following femoral head removal, the next step is to prepare the acetabular bone bed. The acetabulum is prepared in a two-stage process using a **Starter Reamer** initially followed by a **Finishing Reamer** (Fig 2-6). The Starter Reamers are 1 mm smaller than the corresponding Finishing Reamer. The Starter Reamers are odd-numbered, and the Finishing Reamers are even-numbered. The final preparation (with the Finishing Reamer) will accommodate the same size BFX cup or can be used to cement one size smaller CFX cup. Example: a 26 mm acetabular preparation will accommodate a 26 mm BFX cup in a press-fitapplication or a 25 mm CFX cup with bone cement. Cup sizes 19 mm, and smaller are only offered in the CFX cup. CFX cups are available in odd millimeter sizes, while BFX cups come in even millimeter sizes.

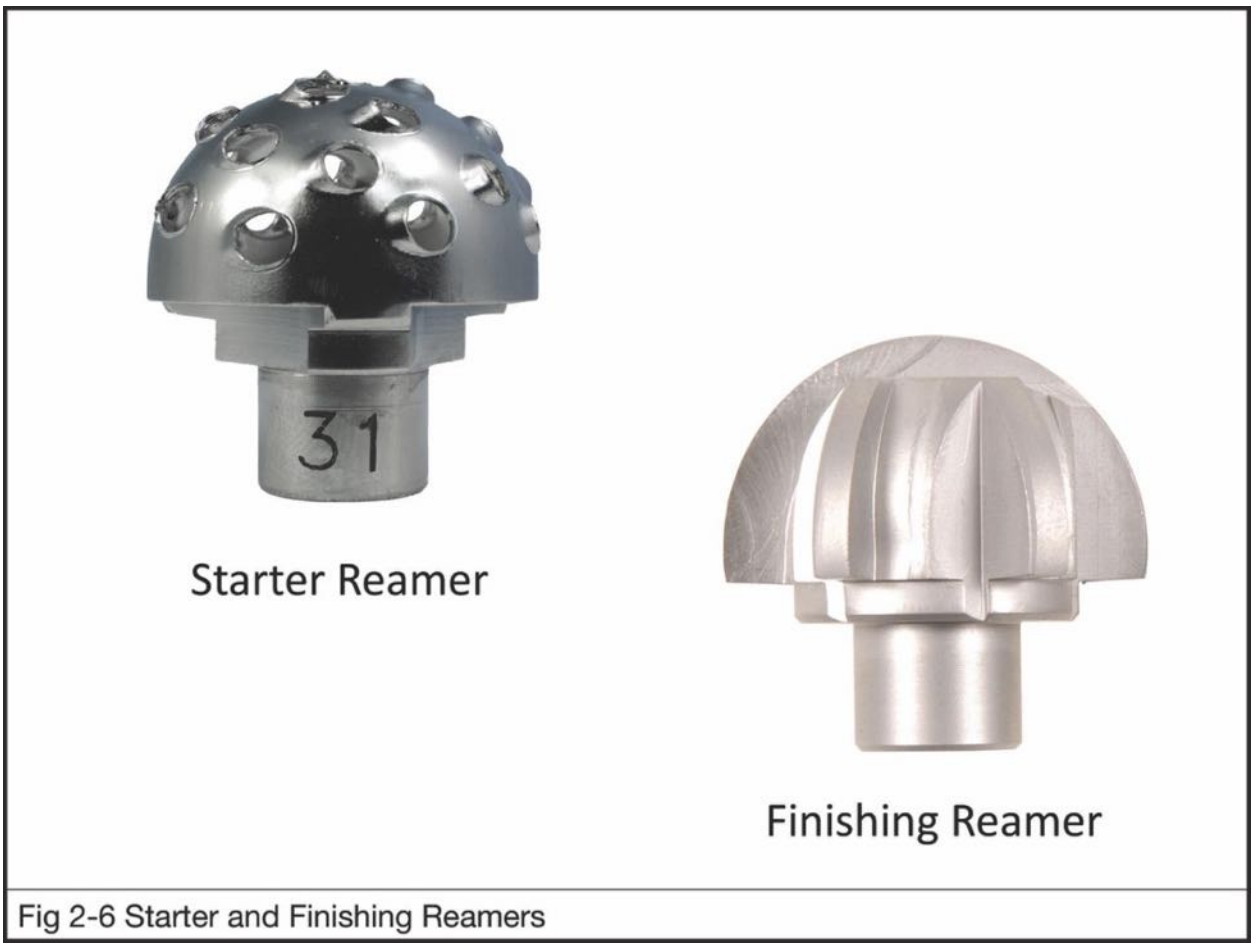


Fig 2-6 Starter and Finishing Reamers

The reamers are attached to an **Acetabular Reamer Shaft** that is covered with a nylon **Acetabular Reaming Sleeve** so that the rotating shaft can be firmly held in position. The reamer shaft is oriented at the correct angle with the aid of either the **Acetabular Alignment Guide** attached directly to the reamer shaft (Fig 2-7) or by holding the reamer shaft parallel to the **Positioning Board Alignment Guide** (Fig 2-8) resting on the dorsal positioning board posts. The choice is based on whether you use the **Positioning Board** or a surgical beanbag.

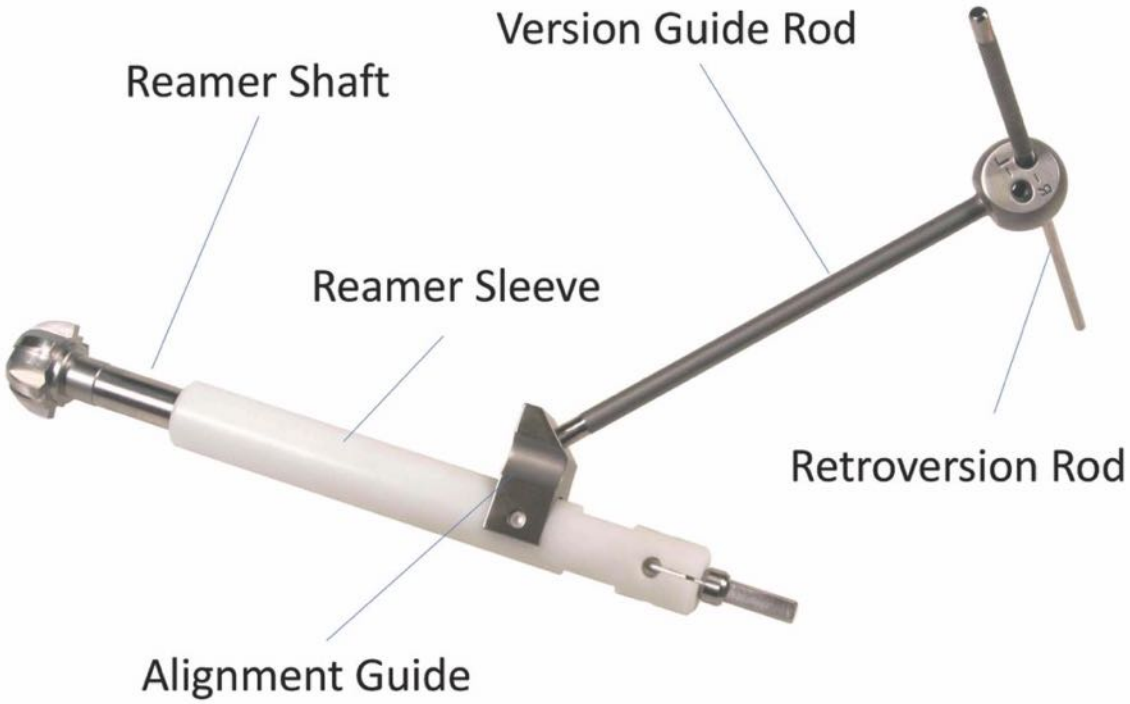


Fig 2-7 Reamer with Acetabular Alignment Guide

Fig 2-8 Positioning Board Alignment Guide

Once the reaming process is completed, a **Trial Acetabular Cup** can be used to give a visual representation of how the cup might appear (Fig 2-9). **The Trial Acetabular Cups** come in five sizes corresponding to the five cup sizes.

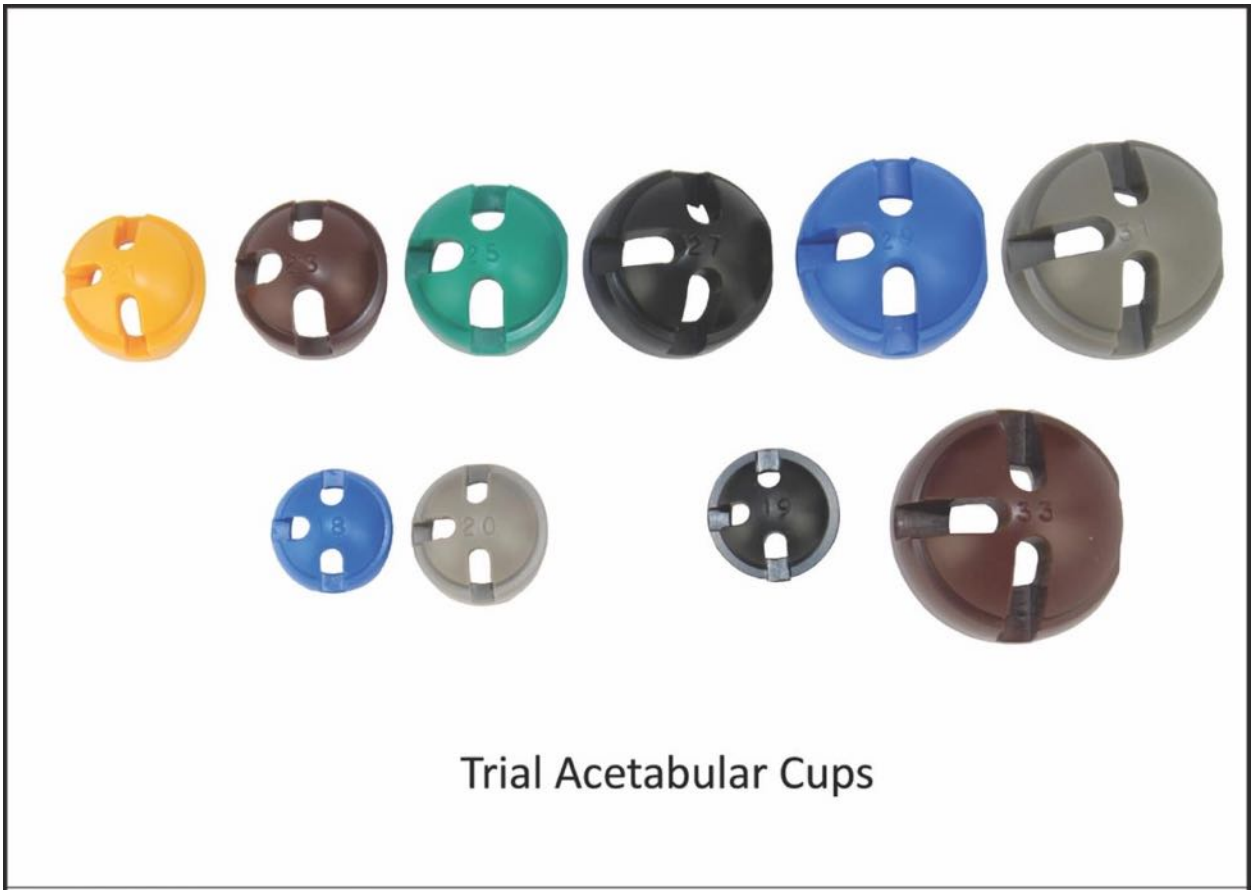


Fig 2-9 Trial Acetabular Cups

Once you are satisfied with the acetabular preparation for a BFX cup, the correct size cup is oriented and partially seated into the prepared bone bed using the same instrumentation used to assess the trial cup. When the cup is seated partly, its orientation can be altered using the **Offset Cup Impactor** in place of the **Central Cup Impactor**. Once you are satisfied with the cup orientation, the cup is impacted until fully seated using the **Mallet** (Fig 2-10).

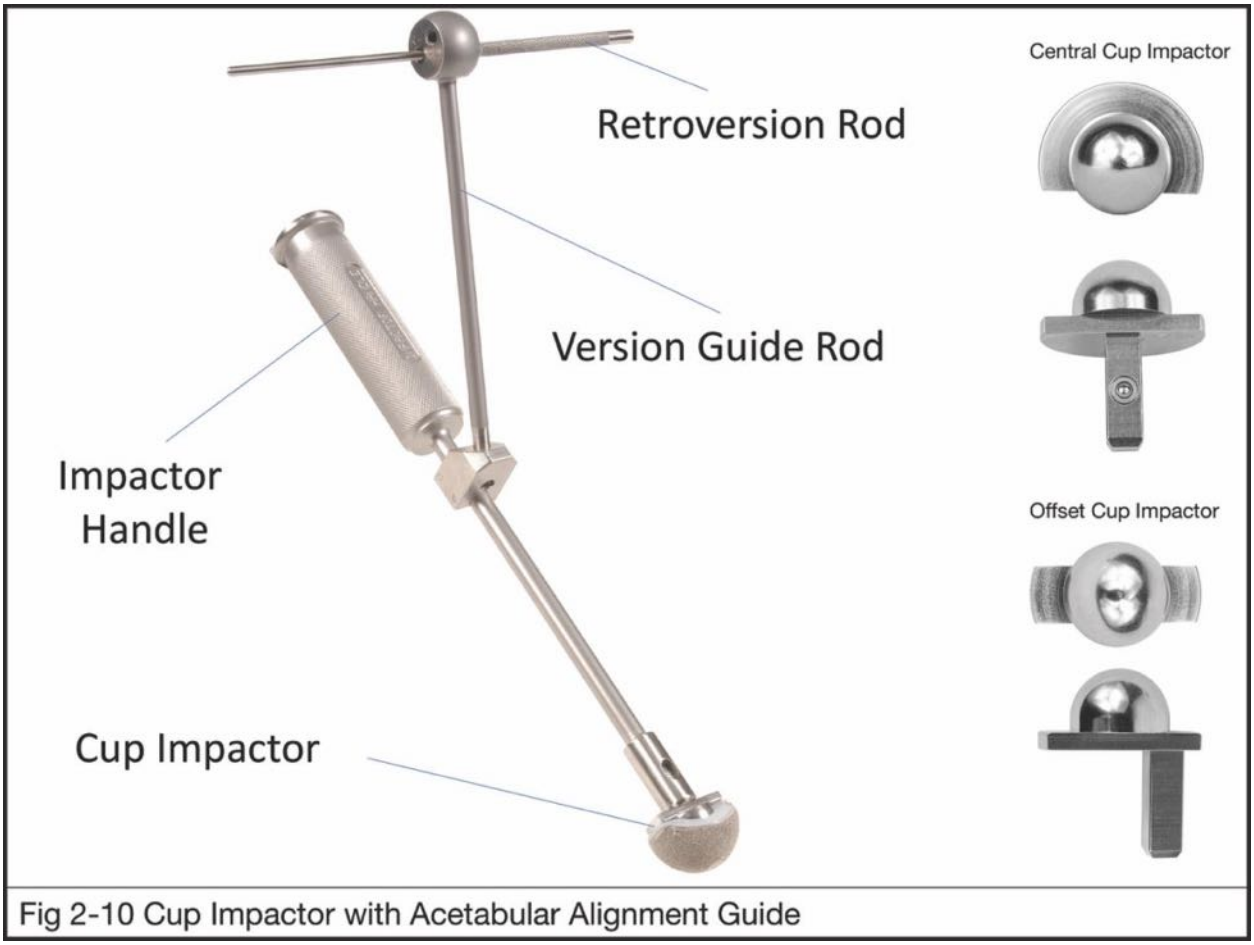


Fig 2-10 Cup Impactor with Acetabular Alignment Guide

The femoral preparation is started by creating an opening into the central femoral canal from the trochanteric fossa with a **3.2 mm (1/8") intramedullary pin**followed by either a **4 mm** or a **5 mm Drill bit (**Fig 2-11). The opening is then expanded with one of the smaller side cutting **Tapered Reamers** (Fig 2-12). During this process, the soft tissues can be protected from the drill bit and reamer using the **Tissue Guard** (Fig 2-13).

5mm Drill

Fig 2-11 5mm Drill

Fig 2-12 Tapered Reamer

Fig 2-13 Tissue Guard

Once an adequate opening has been created, the preparation is expanded by sequential broaching starting with the #4 **Broach** and continuing until reaching the desired final broach size. The final size is based on the pre-operative planning and the intra-operative feedback obtained during the broaching process (Fig 2-14 & 2-15). If the final broach size is a #8, for example, the BFX #8 Stem can be press-fit into that preparation, or a CFX #7 can be implanted with cement. Once the femoral preparation is completed, the appropriate size BFX implant is impacted into the femur until seated using the **Mallet** and the **Impactor Handle** with the **Stem Impactor** attachment (Fig 2-16).

Femoral Broach

Fig 2-14 Broach Close-up

Fig 2-15 Broaches

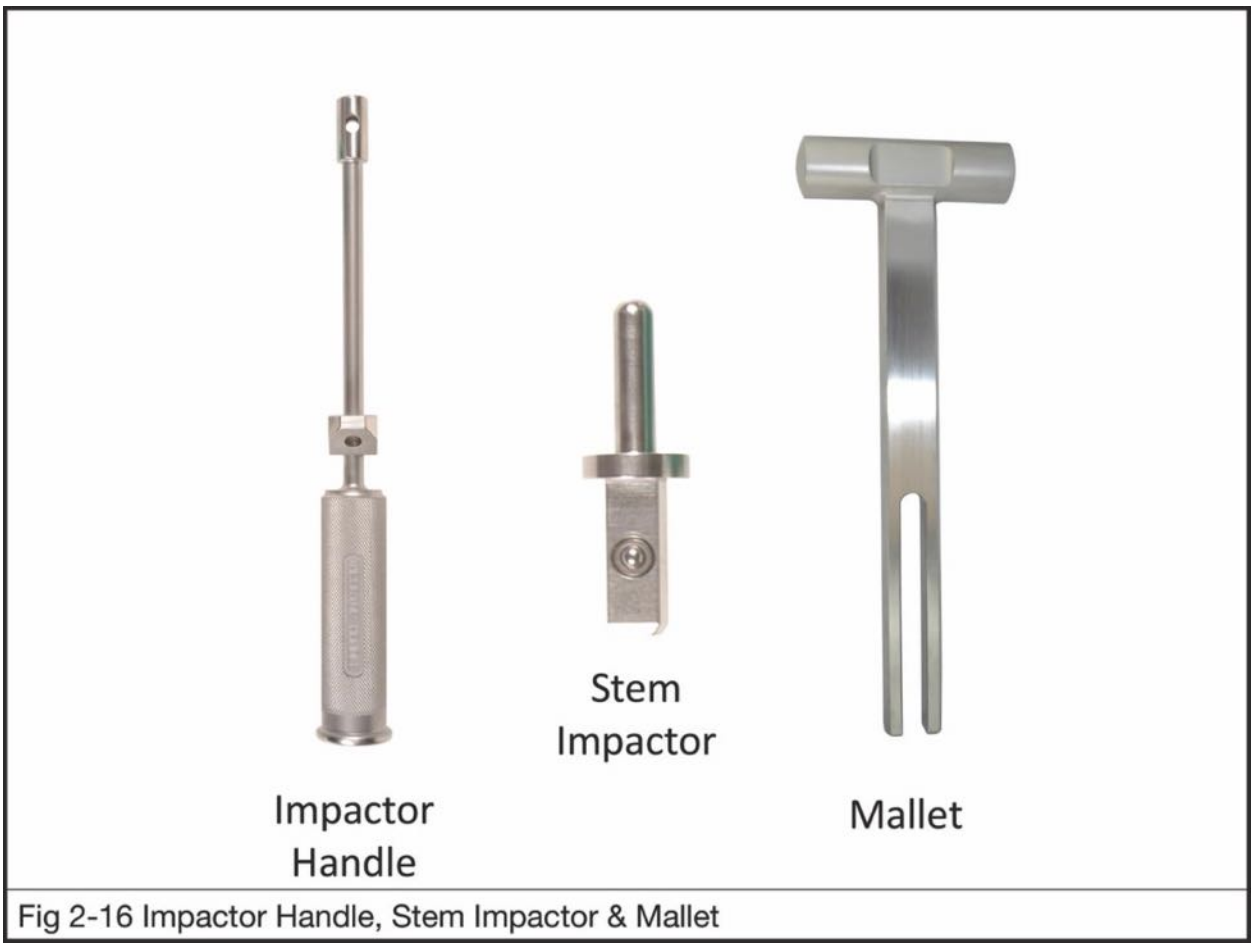


Fig 2-16 Impactor Handle, Stem Impactor & Mallet

The CFX stem and cup utilize bone cement to provide the initial and long-term fixation. The **TechniVet Bone Cement** (Fig 2-17) has powder and liquid components that are mixed during the procedure and injected into the femoral and acetabular bone preparations. When implanting a CFX stem, a **Stem Centralizer** is placed onto the stem tip to prevent the tip from contacting the bone, and to maintain the integrity of the cement mantle surrounding the stem tip. Before inserting the stem, a polyethylene Cement Plug is inserted into the medullary canal to a level just beyond the intended level of the stem tip using the calibrated Cement Plug **Inserter**. The Cement Plug prevents the extrusion of bone cement into the distal medullary canal. The cement is injected using the **Cement Gun** with an attached disposable syringe and cannula (Fig 2- 18). There are CFX **Trial Femoral Stems** to confirm the femoral preparation before cementing the CFX femoral stem (Fig 2- 19).

Fig 2-17 Veterinary Bone Cement

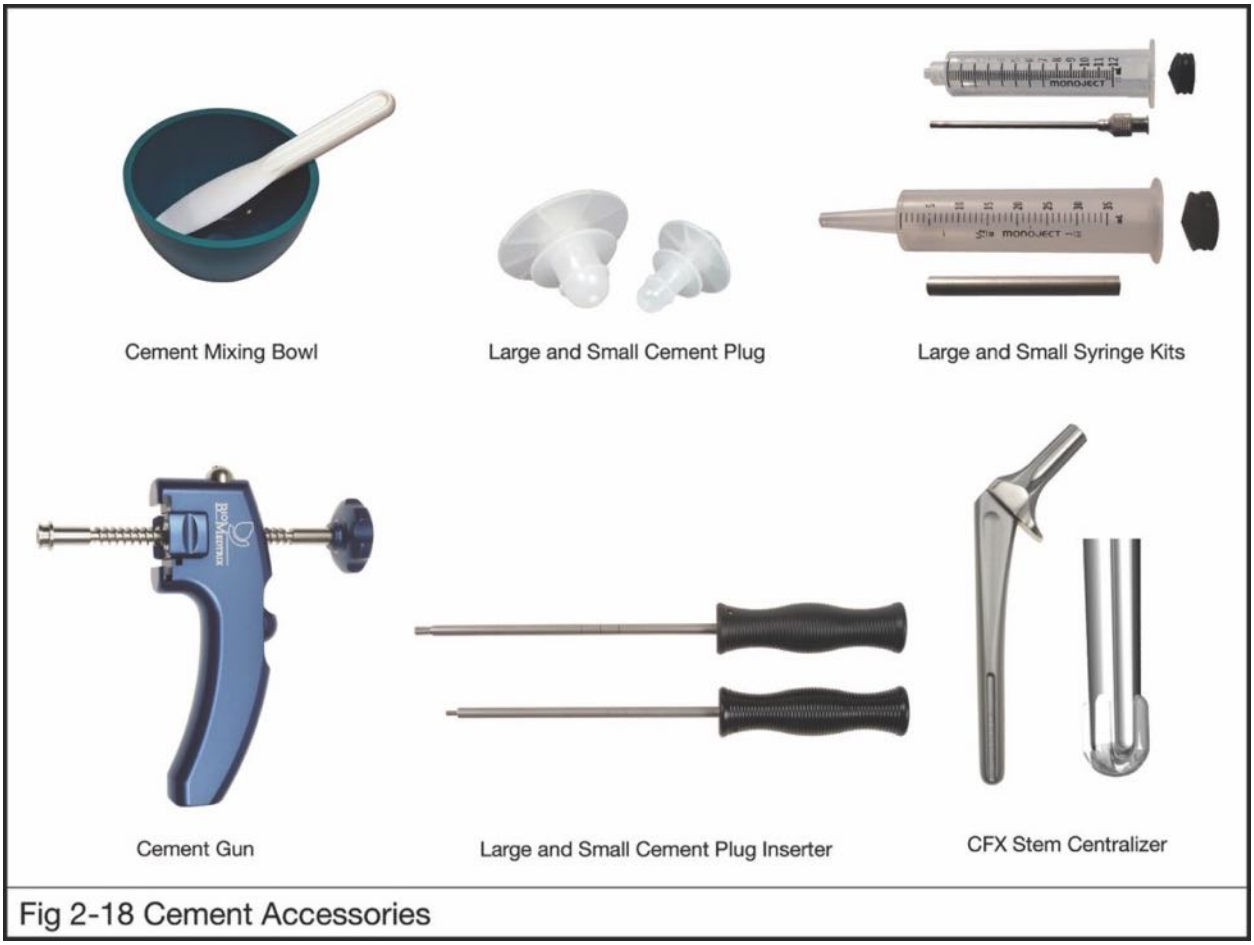


Fig 2-18 Cement Accessories

Fig 2-19 Trial CFX Femoral Stem

If you need to remove a BFX stem after any level of impaction, the **Slide Hammer Stem Extractor** is used if finger traction is inadequate (Fig 2-20).

Fig 2-20 Slide Hammer Stem Extractor

Once the femoral stem is fully seated, **Trial Femoral Heads** are used to aid in determining the final neck length based on the tightness of the reduction (Fig 2-21). The adjustable neck length is created based on the head selected. The head (female) has a bored socket that receives and holds the stem trunnion (male). The various neck lengths are determined by the depth of the bored socket that fits onto the neck of the stem. Once the actual femoral head implant has been selected and assembled to the stem taper, the **Head Impactor** (head covered with gauze to protect the finish) is used to impact the head in place using the **Mallet** (Fig 2-22). These steps are the same for both BFX and CFX stems.

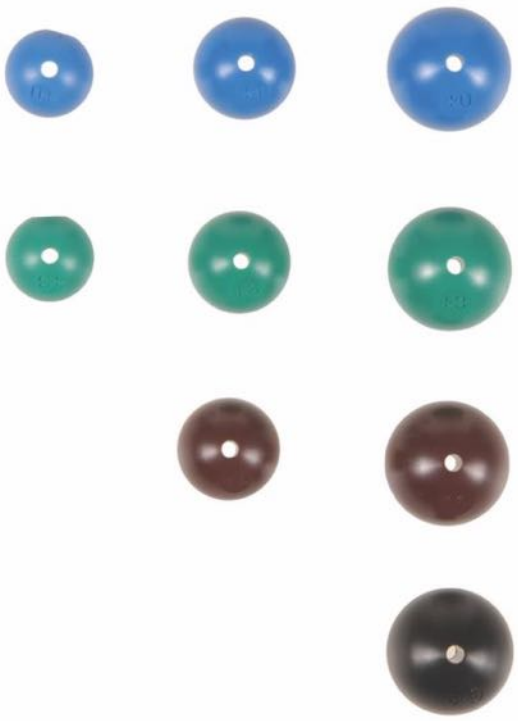


Fig 2-21 Trial Femoral Heads

Fig 2-22 Head Impactor

Module 3 Reading: Preoperative Radiographs and Templating

A thorough evaluation of a patient's radiographic anatomy and determination of the approximate size of the patient's acetabulum and femur are vital to the success of a total hip replacement procedure. A preoperative radiographic review should be considered as the initial step in the surgical planning of the THR procedure.

The goals of the preoperative radiographic assessment are:

1. To identify potential intraoperative challenges that may result from abnormal bone morphology, degenerative remodeling changes including saucerization of the acetabulum,

femoral canal sclerosis, and medialization of the greater trochanter. The loss of "normal" coxofemoral anatomy associated with advancing hip joint degeneration or trauma significantly increases the difficulty of the procedure.

2. To determine the approximate size implant components needed for a particular patient. Implant size is especially important in BFX total hip procedures where achieving a stable press-fit relies on choosing implants that closely match the actual size of the patient's acetabulum and femoral canal size.
3. To determine the inventory of implants and supplies that must be on hand before the surgical procedure. It is essential to keep in mind that the final selection of an implant is made during surgery based on the quality of bone encountered during the broaching and reaming procedures. Also, unexpected intraoperative complications may happen that require a change in the type implant.

Radiographic Procedure

A magnification indicator of known size is used to determine the degree of magnification of the bone on patient radiographs. The BioMedtrix X-ray Magnification Indicator is 10 cm long between the centers of two metal balls embedded in an acrylic bar or 10 cm from the top of one ball to the top of the opposite ball.

The key considerations in obtaining the accurate magnification on the radiographs are:

1. The position of the acetabulum or the proximal aspect of the femur must be parallel to the digital radiographic (DR) detector or the computed radiography (CR) cassette.
2. The position of the magnification indicator must be parallel to the DR detector or the CR cassette.
3. The position of the magnification indicator must be at the same height from the DR detector or the CR cassette as the acetabulum or the proximal aspect of the femur.
4. The x-ray beam must be directed perpendicular to the DR detector or CR cassette.

Failure to meet these criteria will result in a misrepresentation of the size of the patient's bone, contributing to complications.

Four preoperative radiographic views are required:

The **Ventrodorsal view of the pelvis** (Fig 3-1) is positioned primarily for the assessment of the pelvis and acetabulum (Fig 3-2). Preference is given to provide square alignment of the pelvis rather than the accurate positioning of the femurs. The disease process in the hip joint often prevents full extension of the hip joint and results in an inaccurate and distorted view of the femurs. The femurs can be either extended or frog-legged.

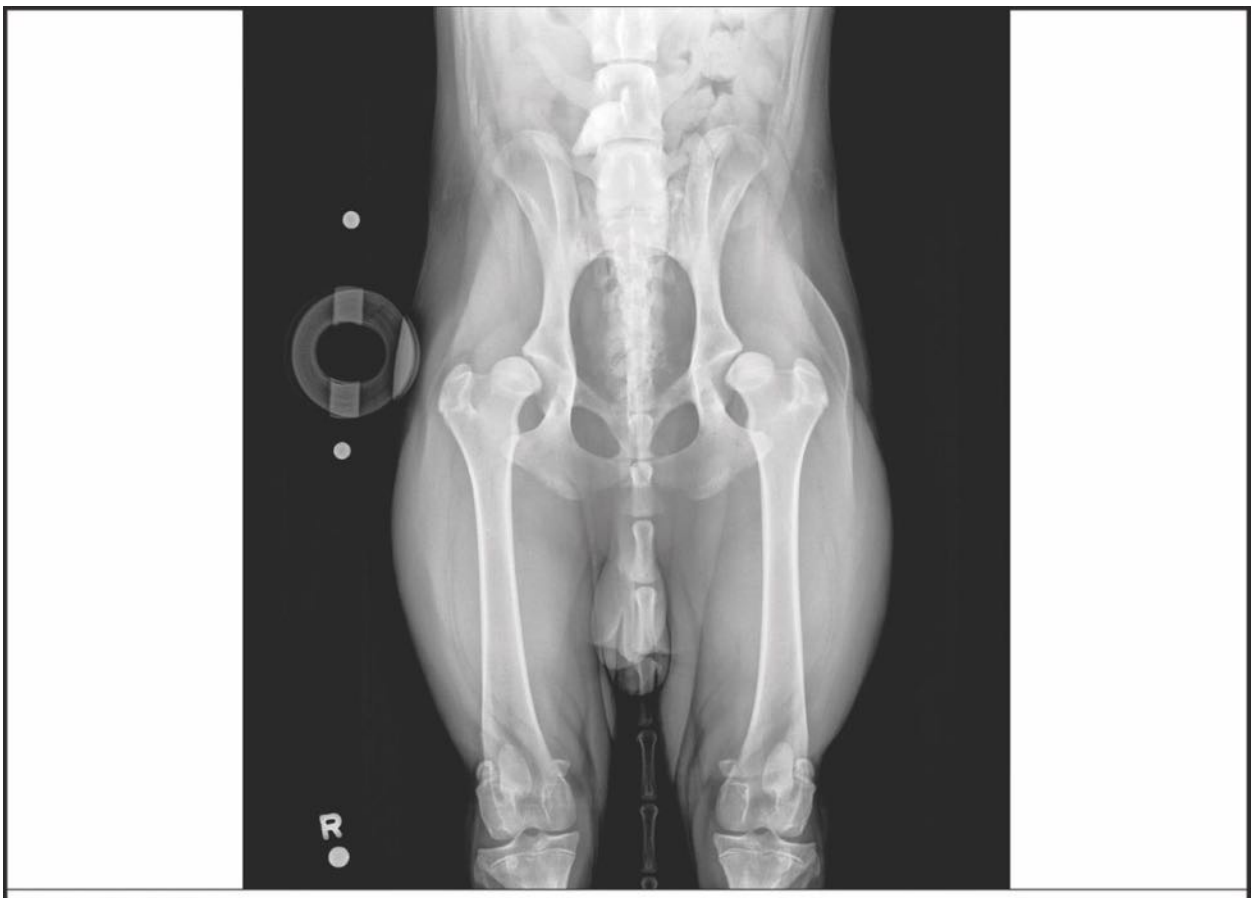


Fig 3-1 VD Pelvis

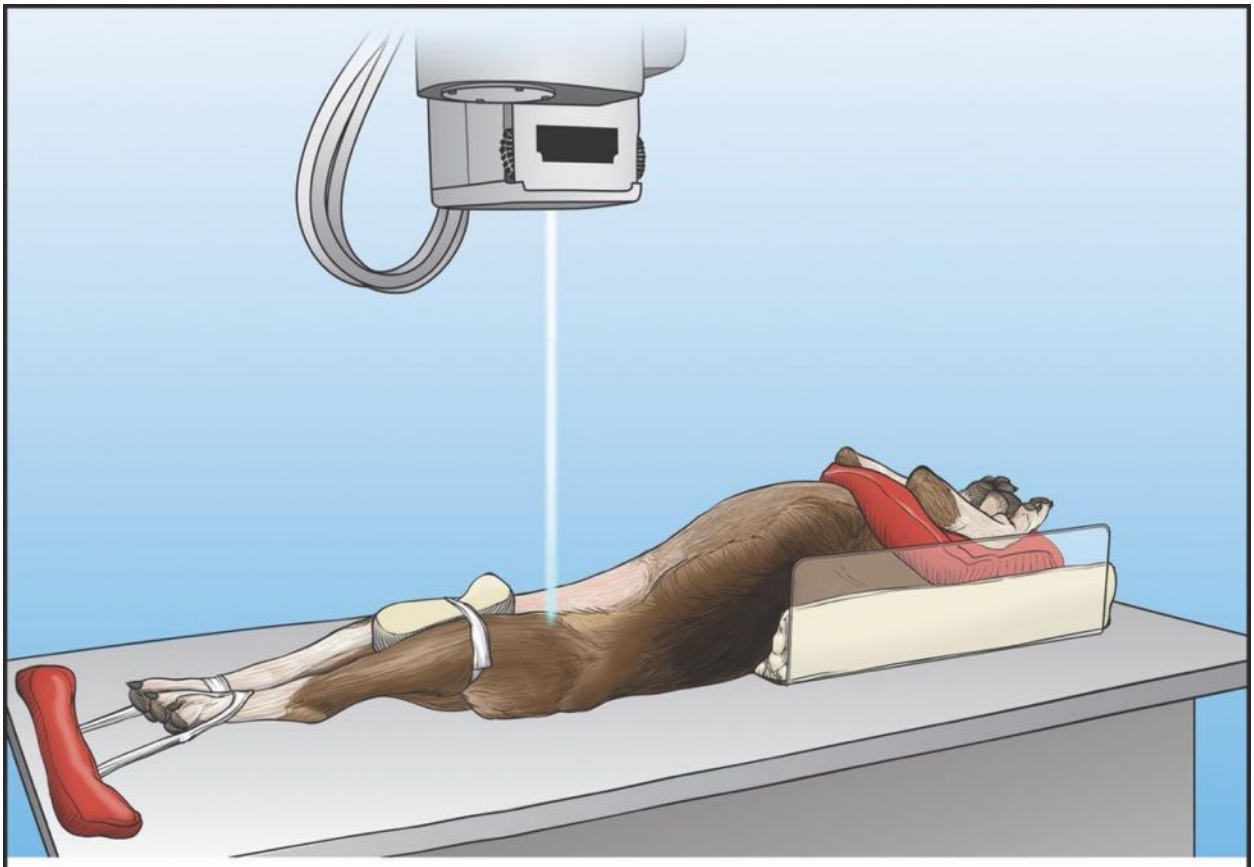


Fig 3-2 VD Pelvis Radiograph Positioning

The **Lateral view of the pelvis** (Fig 3-3) is made with the dog positioned with the affected limb down, the hip joint slightly flexed, and the upper hind leg extended and pulled caudally to separate the proximal portion of the femurs (Fig 3-4). Both limbs are positioned parallel to the radiographic film and not rotated at the hip joint. The hemipelves are superimposed rather than oblique.

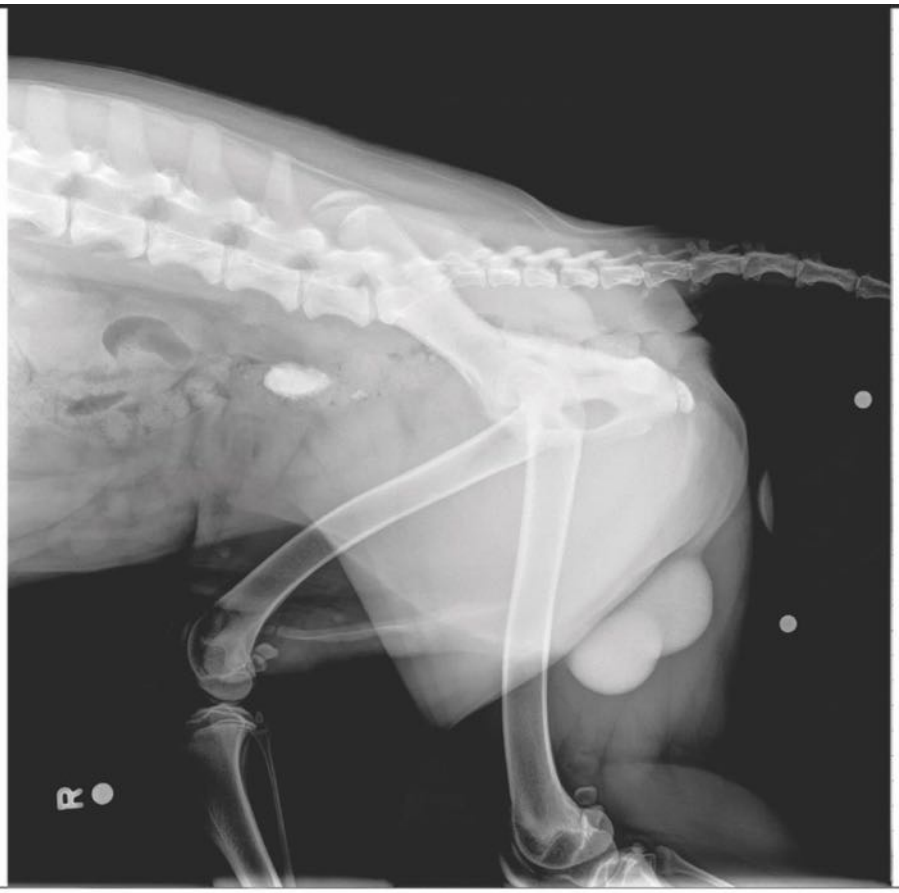


Fig 3-3 Lateral Pelvis

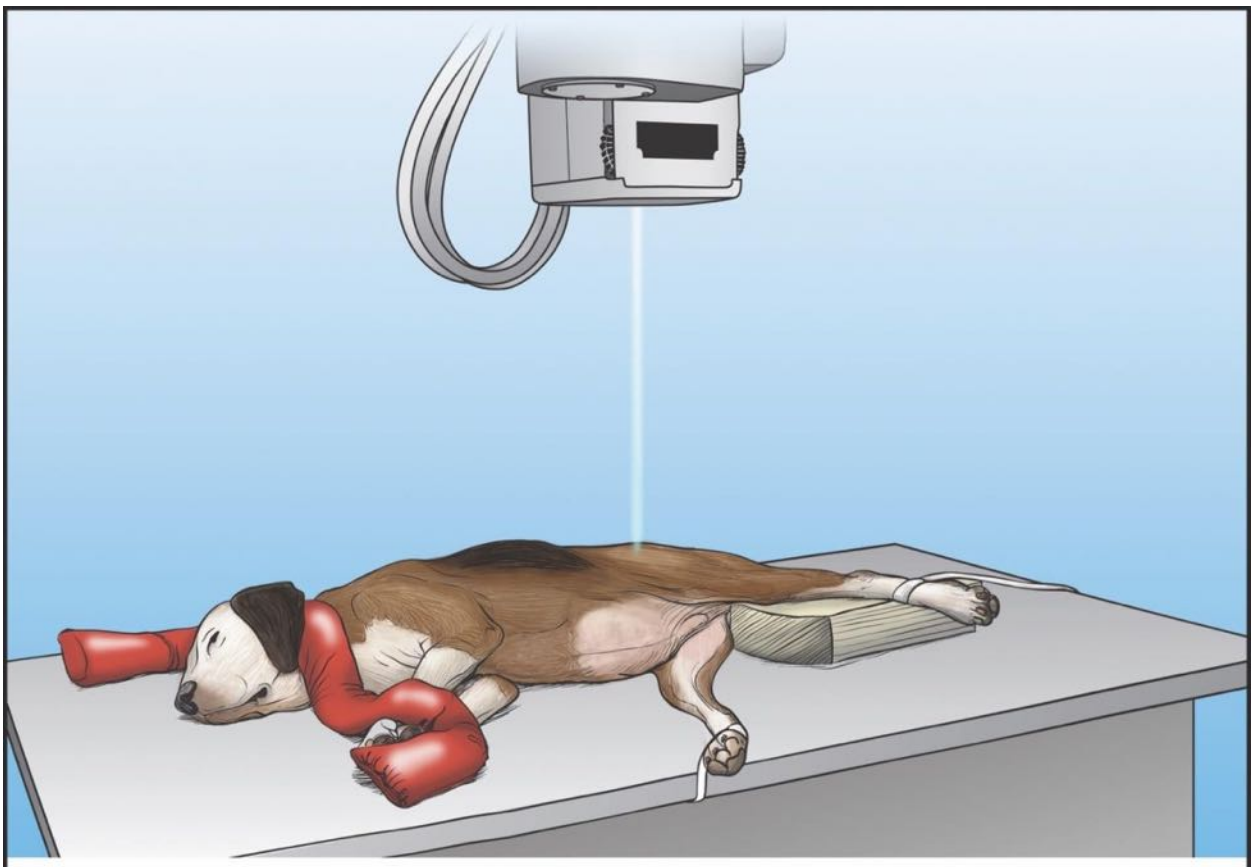


Fig 3-4 Lateral Pelvis Radiograph Positioning

The **Open-leg Mediolateral view of the femur** (Fig 3-5) is made with the dog positioned in lateral recumbency with the affected limb down and the femoral condyles superimposed. The top leg is flexed and abducted dorsally to expose the groin area and provide an accurate lateral view of the entire femur (Fig 3-6). This retraction of the up leg rotates the pelvis and provides a profile view of the acetabulum, and postoperatively of the implanted cup not seen in other views. Also, it gives an accurate view of the entire femur without the superimposition of the top leg.

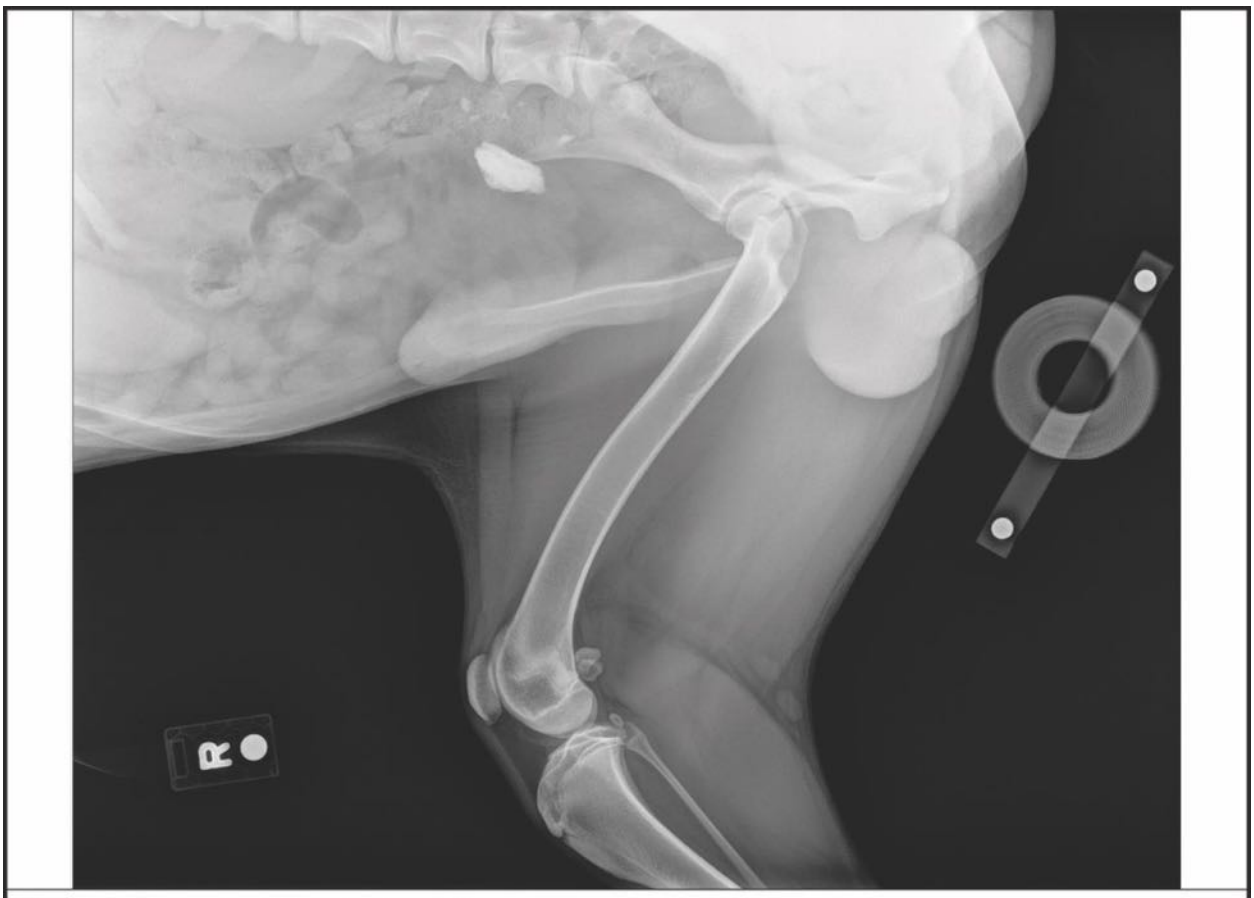


Fig 3-5 Open-Leg Mediolateral Femur

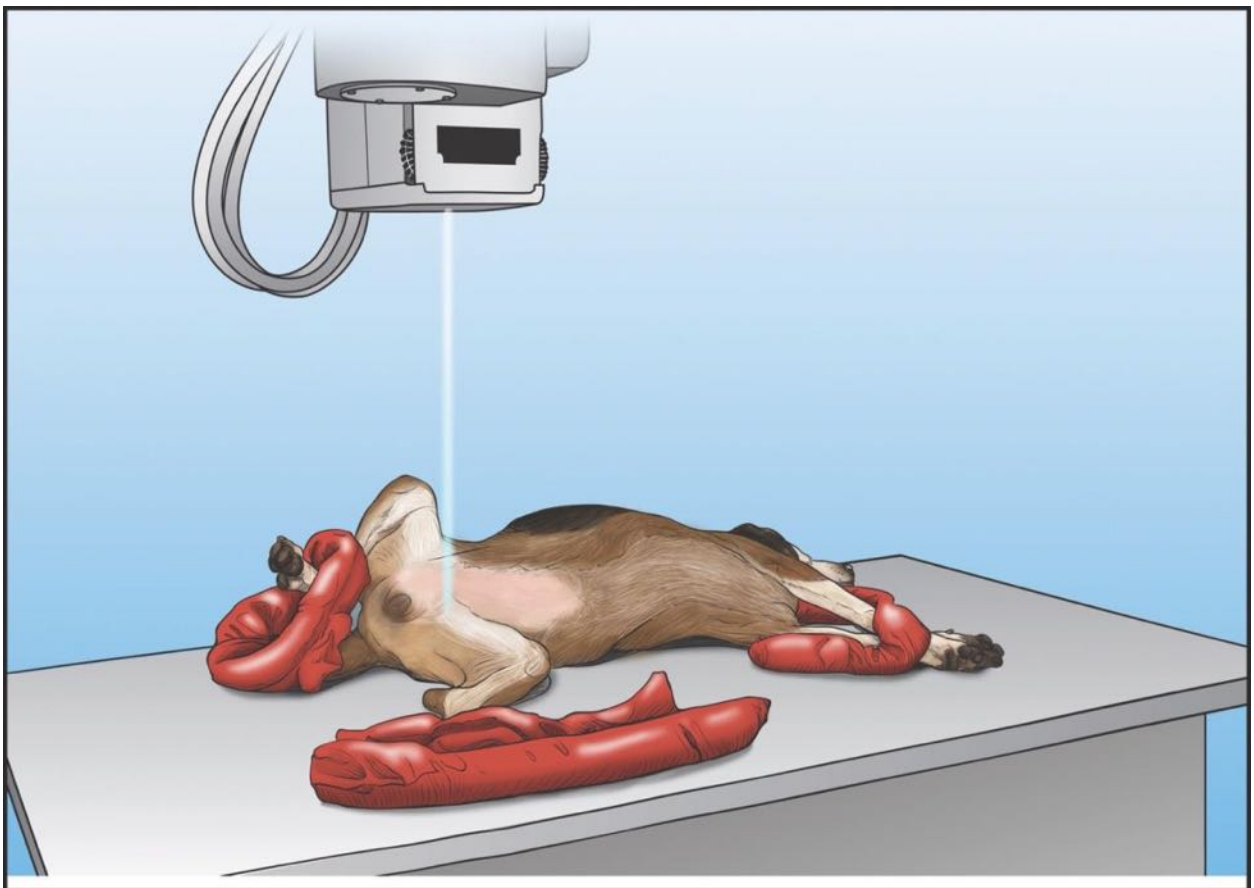


Fig 3-6 Open-Leg Mediolateral Femur Radiograph Positioning

The **Craniocaudal view of the femur** provides an accurate anatomical representation of the fully extended femur (Fig 3-7). If CR is used, the dog is positioned in lateral recumbency with the affected limb up and the patella centered between the condyles. The CR cassette is placed parallel with and caudal to the femur with the x-ray beam directed horizontally from cranial to caudal at 90 degrees to the cassette (Fig 3-8). If you are using DR with the detector mounted in the table, position the patient in dorsal recumbency and elevate the upper body and pelvis until full extension of the entire femur can be achieved with the femur parallel to the cassette (Fig 3-9). This view provides an accurate and reproducible representation of the femur for templating and for postoperative serial radiographic assessment.

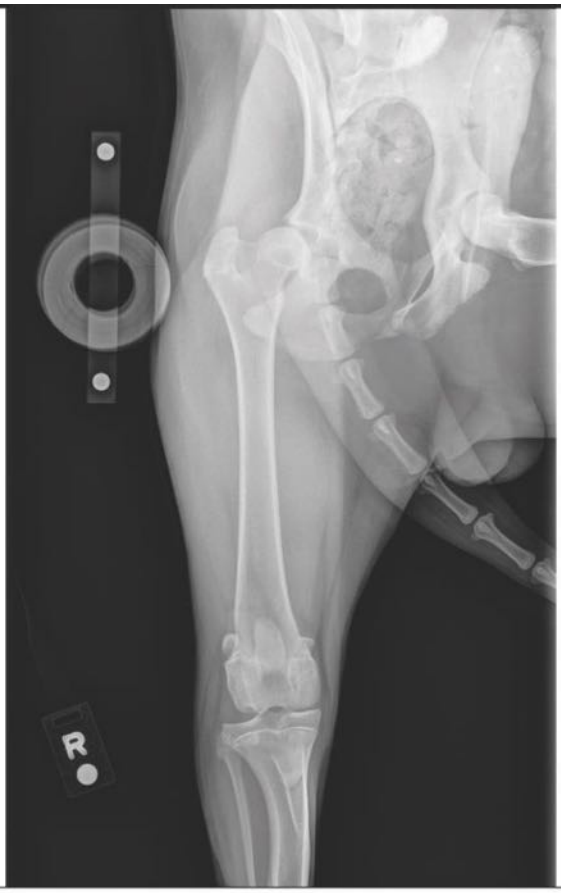


Fig 3-7 Craniocaudal Femur

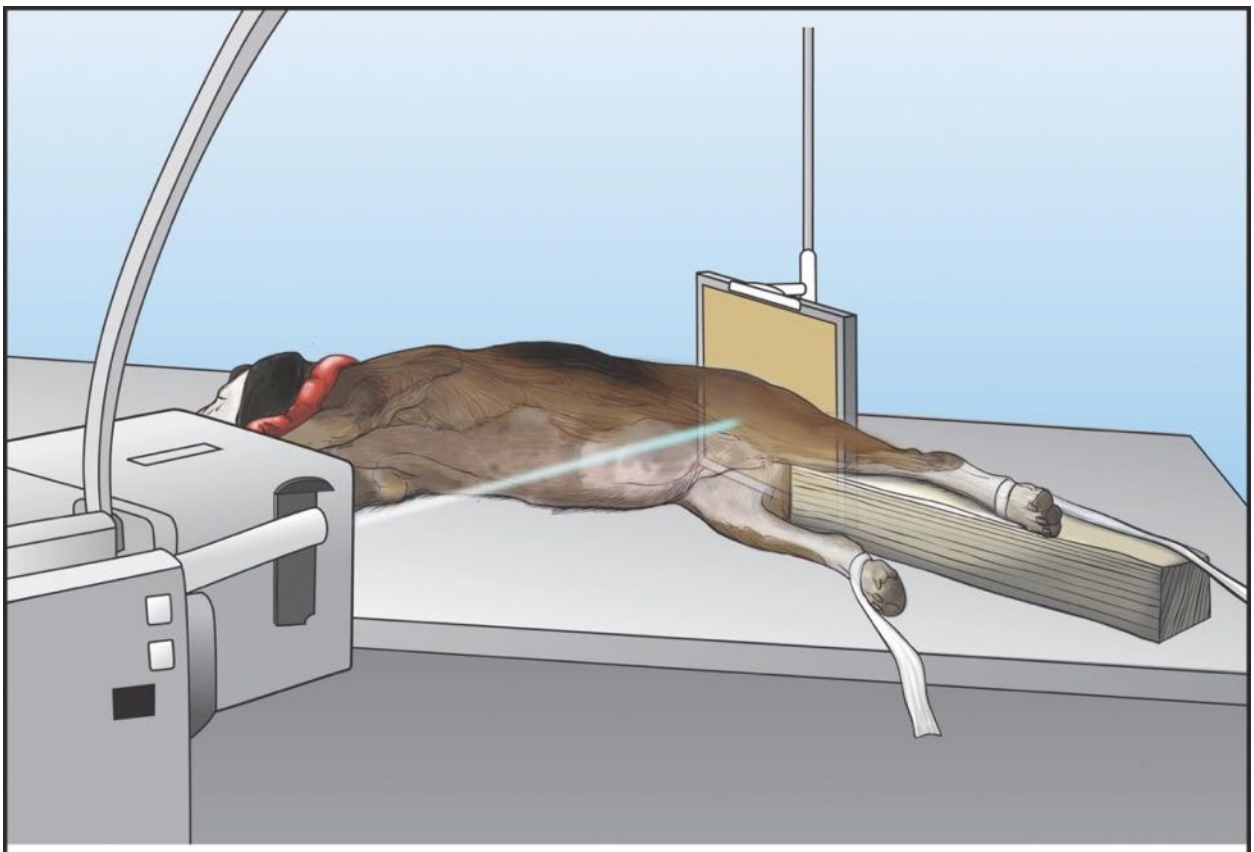


Fig 3-8 Craniocaudal Femur Radiograph Positioning: Horizontal Beam CR

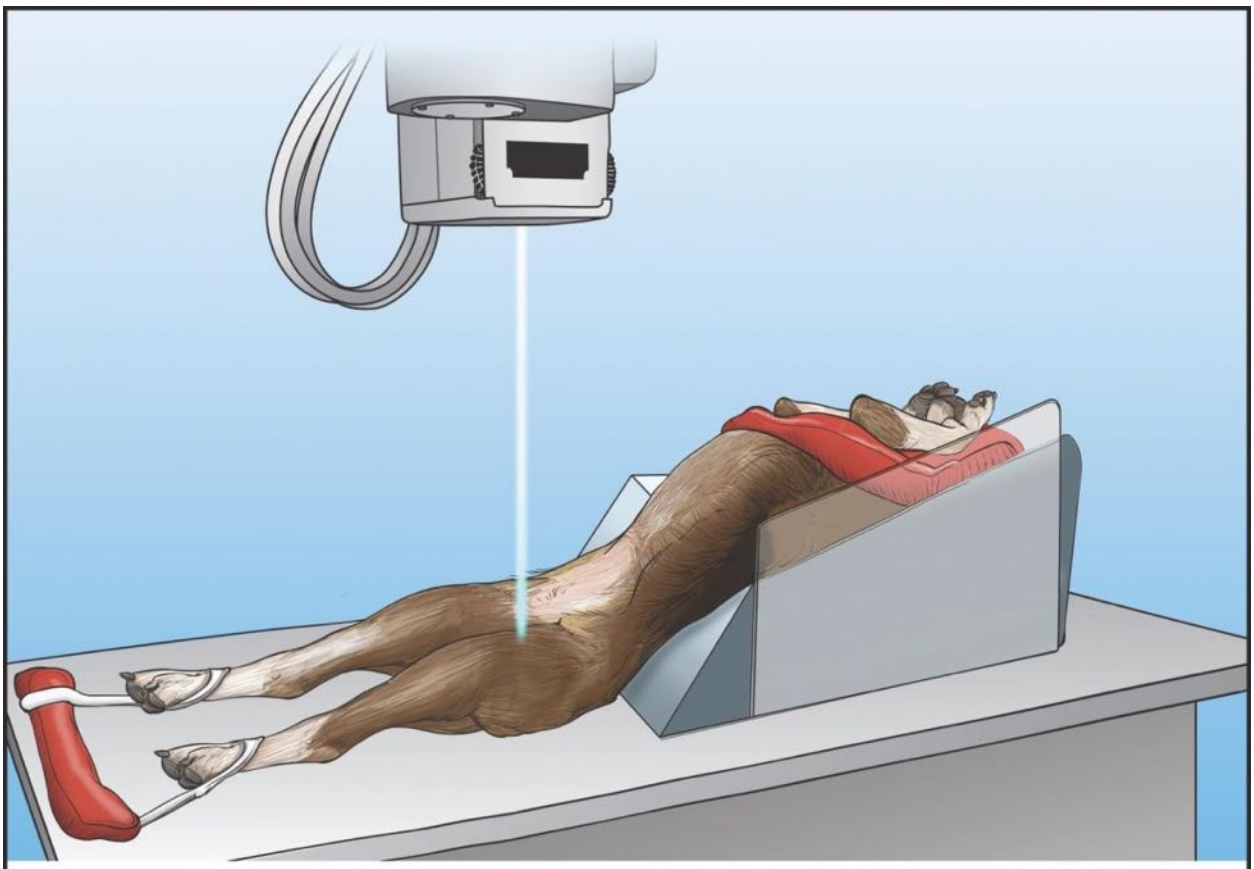


Fig 3-9 Craniocaudal Femur Radiograph Positioning: Vertical Beam DR

The same radiographic protocol is followed for all postoperative radiographic follow-up.

Radiographic Templating

Implant size can be estimated on digital radiographic images using either a validated digital software program or an acetate template. When using the digital software program, the size of the magnification indicator, as viewed on the digital radiograph, is measured and then calibrated to its known actual size of 10 cm. Digital images of the various implant sizes are then aligned into proper position over the bone on the digital radiograph. When using the acetate templates, the ruler on the acetate is positioned over the calibrated Magnification Indicator on the digital radiographic image. The image size is then adjusted until the length of the Magnification Indicator matches the ruler size on the 100% acetate template. Note: Ensure you measure from the top of one metal ball to the top of the opposite metal ball. Template images of the different implant sizes on the acetate can then be aligned into proper position over the radiographic image for implant sizing.

BFX Acetabular Implant Sizing

The VD view of the pelvis is used for acetabular component sizing. The template images of the different sized acetabular components are positioned over the acetabulum to determine the size

cup that best fits within the cranial to caudal margins of the acetabulum (Fig 3-10). The cup template is aligned over the acetabulum in approximately 15-20 degrees of retroversion. The cup should fit just beyond the subchondral bone cranially and caudally and at or nearly at the medial wall of the acetabulum. It is more important that the cup fits within the cranial-caudal margins of the acetabulum than at the medial wall. The optimal cup size does not remove excessive bone and closely matches the cranial to caudal acetabular width. Undersizing the cup must be avoided as this could result in an increased risk of postoperative luxation. Whereas oversizing the cup may result in removing an excessive amount of bone at the caudal aspect of the acetabulum, jeopardizing the ability to achieve a stable press-fit. While templating the acetabulum, also take note of the location and size of osteophytes, any loss of dorsal acetabular rim, and the degree of subchondral bone sclerosis.

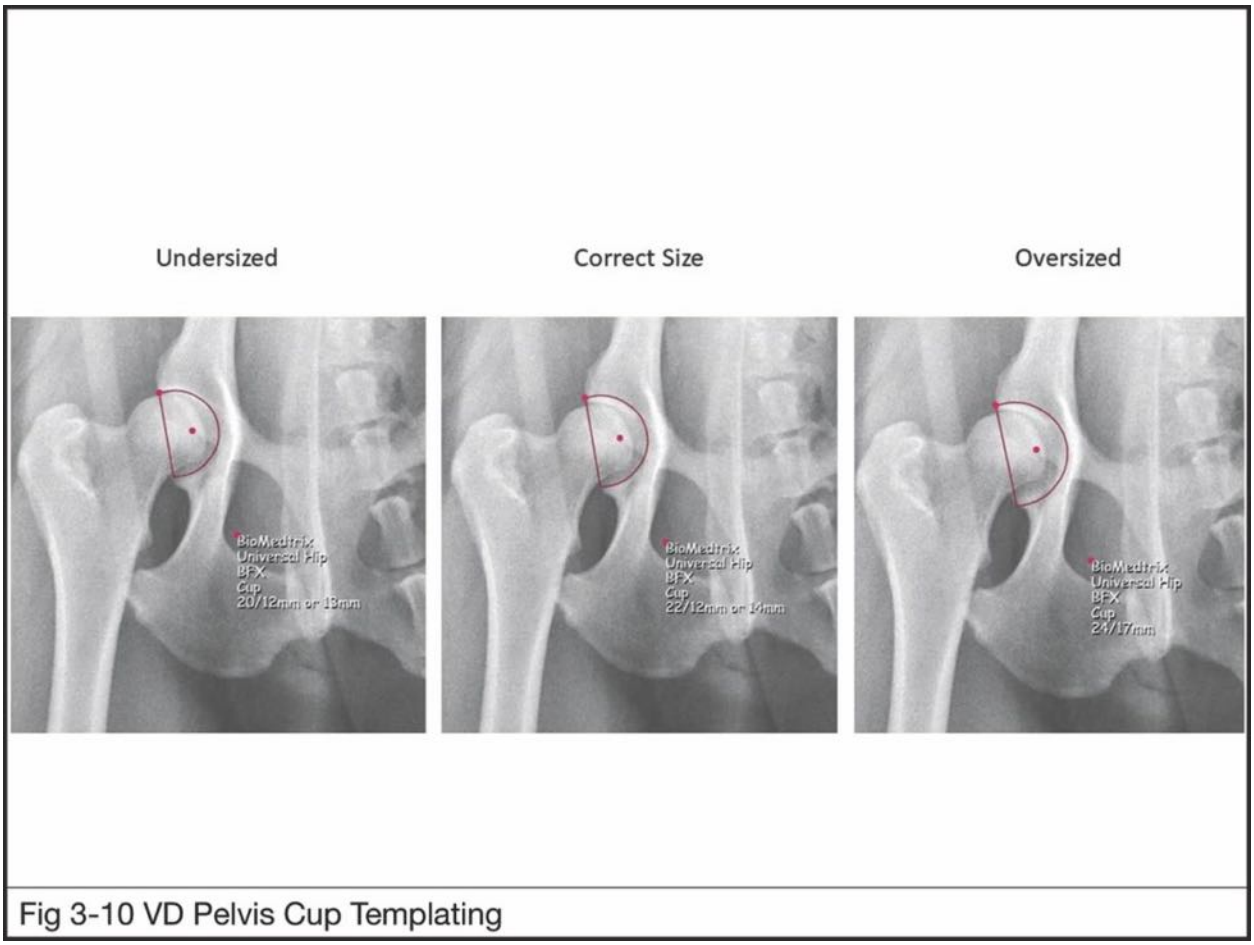


Fig 3-10 VD Pelvis Cup Templating

CFX Acetabular Implant Sizing

The templating process is as described above for the BFX cup. The metal shell of a BFX cup supports the polyethylene liner making complete dorsal acetabular bony coverage of the implant less crucial. For a CFX cup, complete dorsal rim coverage is essential for long term cup stability and must be assessed during CFX cup templating. Also, the medial wall of the acetabulum must be maintained during CFX cup preparation to prevent cement extrusion into the pelvic canal. As a general rule, the size of a CFX cup will be 1-2 sizes smaller than the appropriate sized BFX cup.

BFX Femoral Implant Sizing

The craniocaudal and open-leg mediolateral radiographic views are used to size the femoral component. The templates are superimposed over the anatomic axis of the femur in both the cranial-caudal and open-leg mediolateral views to determine an approximation of the femoral implant size. The template image must be seated to the appropriate level within the bone for accurate templating. In surgery, the goal is to position the proximal-lateral "shoulder" of the femoral stem at the level of the origin of the vastus lateralis muscle on the cranial surface of the femur. This point is a palpable bony prominence known as the "vastus ridge". For templating, the approximate level of the vastus ridge is identified on the craniocaudal radiographic view from the sclerotic "c-shaped" region of the medial greater trochanter. At the appropriate insertion depth, the proximal-lateral "shoulder" of the implant should be located at the proximal 1/3 of the sclerotic c-shape noted on the medial greater trochanter (Fig 3-11).

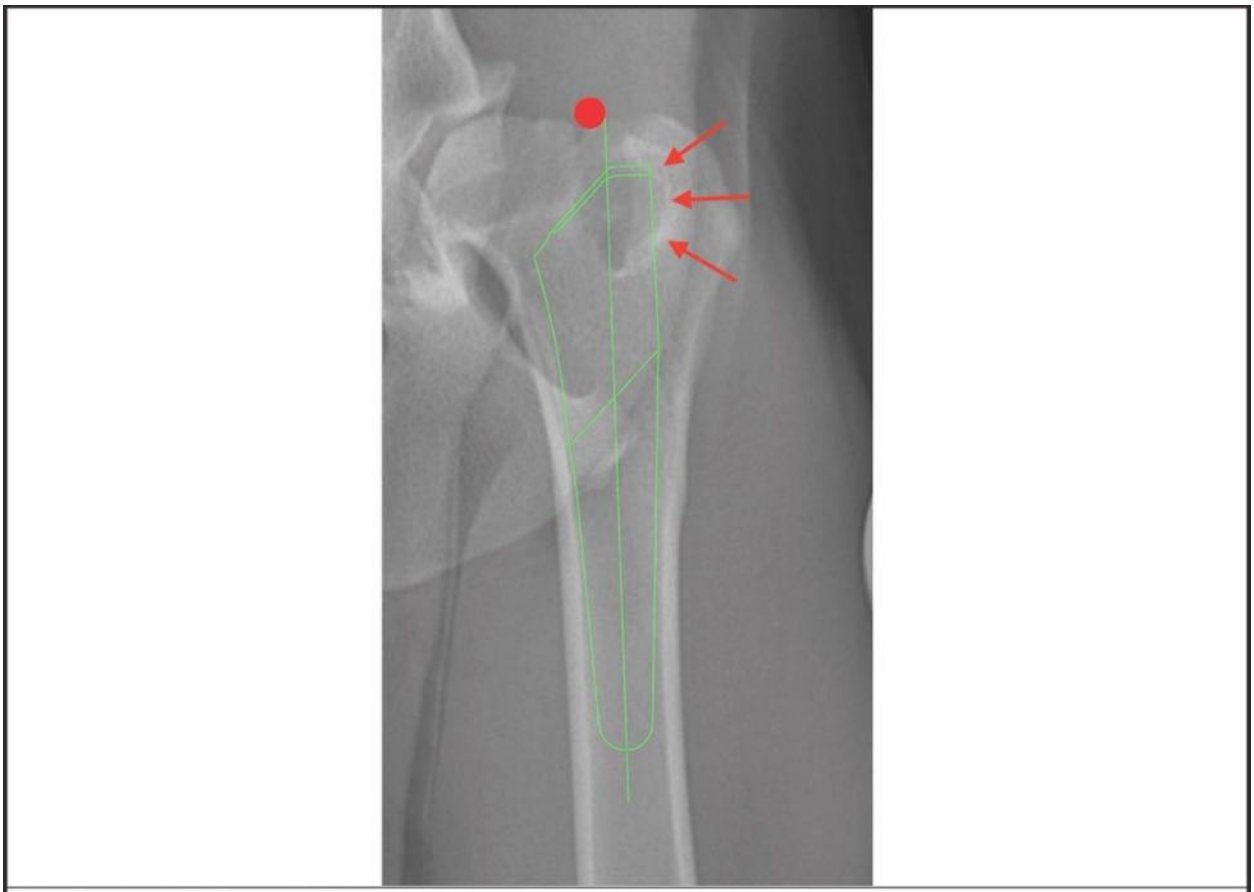


Fig 3-11 "C" Shaped Medial Edge of the Greater Trochanter

Starting with the craniocaudal view, position a smaller size stem template over the proximal femur. Align the template with the anatomic axis of the femur and lower it into the femoral canal to the appropriate insertion depth. Sequentially increase the size of the templates over the bone, noting the fit and fill of the implant relative to the bone, particularly at the porous-smooth junction of the stem. Identify the implant size that visually fits well within the endosteal

dimensions of the femur adjacent to the porous-smooth junction. Leave 1-2 mm of space medially and laterally between the edge of the implant and the endosteum from the porous-smooth junction to the tip of the stem (Fig 3-12). Fit and fill are crucial parameters for creating a stable press-fit. Canal fit is the distance between the implant and the endosteum. Canal fill, on the other hand, is the percent of the canal occupied by the area of the stem. The stem should have the best fit and the fill and be of reasonable size to implant without breaking the femur.

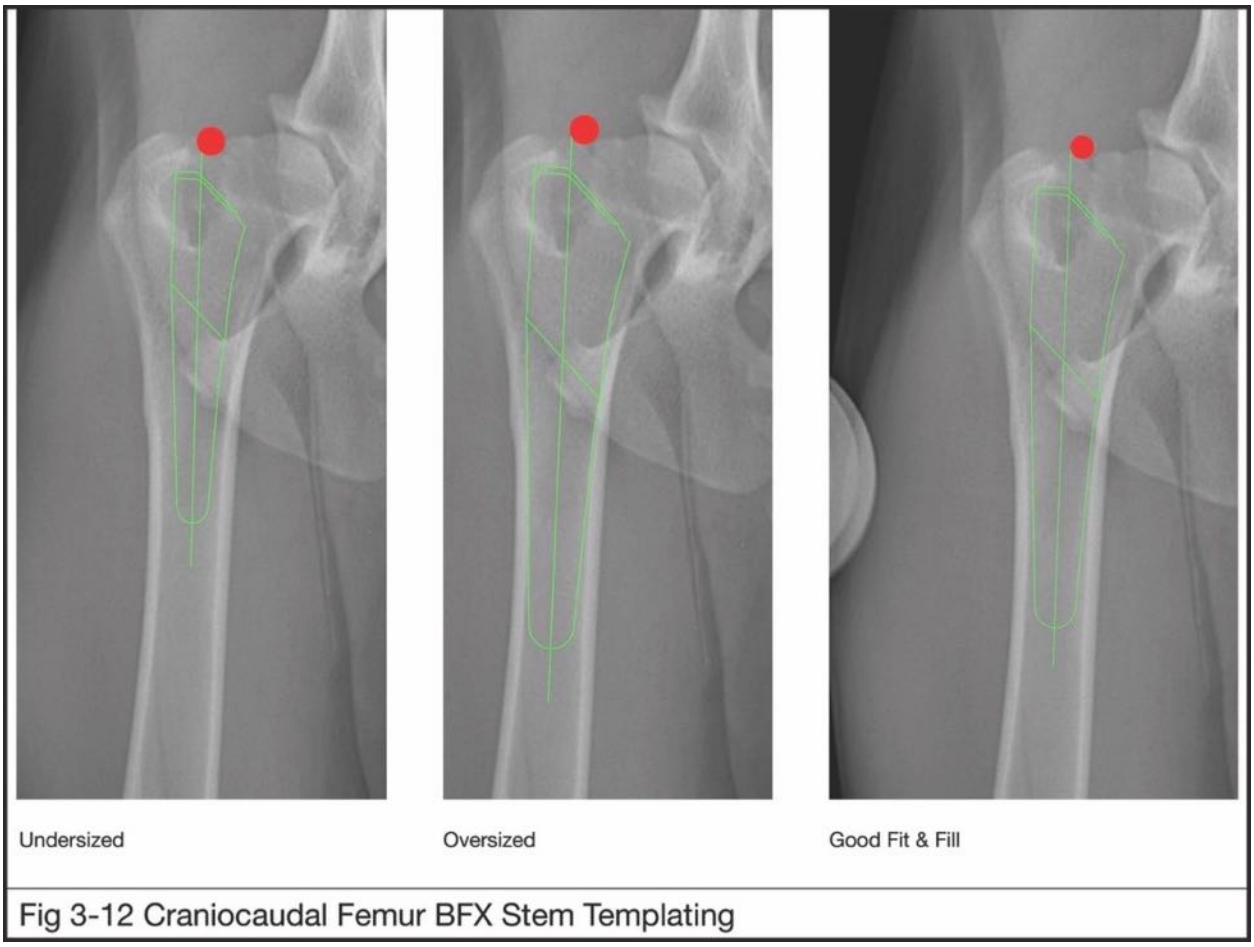


Fig 3-12 Craniocaudal Femur BFX Stem Templating

It is beneficial to note the absolute largest stem that would fit in the femoral canal based upon fit at the distal stem tip. The endosteal diameter at the stem tip is often the size limiting point of the bone for implant size, especially in a "champagne fluted" femur. Based upon your templating, you should know the size implant that you are expecting will achieve press-fit. However, if you are not able to achieve press-fit during surgery and are contemplating going up a size, knowing the largest implant that will fit is essential. Keep in mind that oversizing an implant may increase the risk of femoral fissure or fracture. Conversely, undersized implants may be at increased risk of subsidence. Ultimately, templating is a guideline for the size implant to be placed. The ultimate decision is based upon the surgical assessment of press-fit during the broaching process. **It is important to realize that canal fill does not equal press-fit.**

Once you have selected the appropriate size implant based on the craniocaudal radiograph, measure the linear distance from the proximal aspect of the greater trochanter to the lateral shoulder of the implant image. When positioning the template on the open-leg mediolateral view, place the shoulder of the implant image at the same level based on your previous measurement (Fig 3-13). In most patients, it is the endosteal width of the femur on the craniocaudal view that will dictate the appropriate stem size, not the endosteal width on the open-leg mediolateral view of the femur. However, both views should be templated. It is expected on the open-leg mediolateral radiographic view that the implant will fill less of the femoral canal, and this is normal.

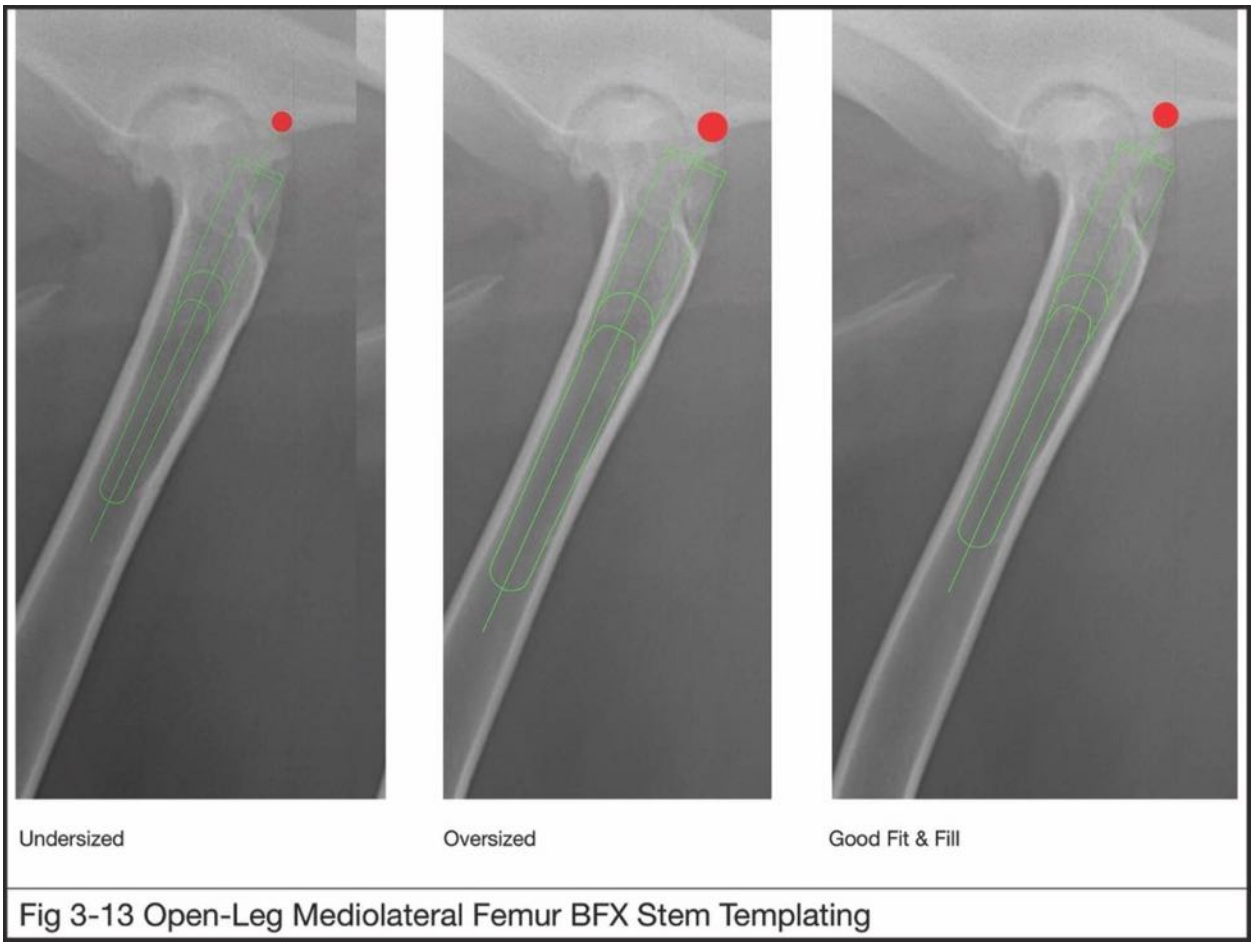


Fig 3-13 Open-Leg Mediolateral Femur BFX Stem Templating

Once the size stem is determined, the template is used to establish the position of the anatomic axis of the proximal femur relative to the patella. This information helps determine a landmark for aligning the instruments during femoral preparation. In a normal shaped femur, the patella is an accurate landmark for determining valgus-varus alignment of the broach during surgery. However, because of the varying degrees of procurvatum of the canine femur, the patella is not a consistently reliable landmark for determining the cranial-caudal orientation of the stem. When the template is aligned in the proximal femur on the open-leg mediolateral view, a line drawn

through the long axis of the stem distally does not generally bisect the patella. The line is often cranial to the patella and varies with the degree of procurvatum of the femur. The location of the line relative to the patella and condyles is noted and helps align the instruments in the cranial-caudal direction during surgical preparation of the femoral canal. In dogs with minimal curvature, the line will exit close to the top of the patella (Fig 3-14A). In dogs with pronounced caudal curvature of the femur, the line will be well cranial to the patella (Fig 3-14B).

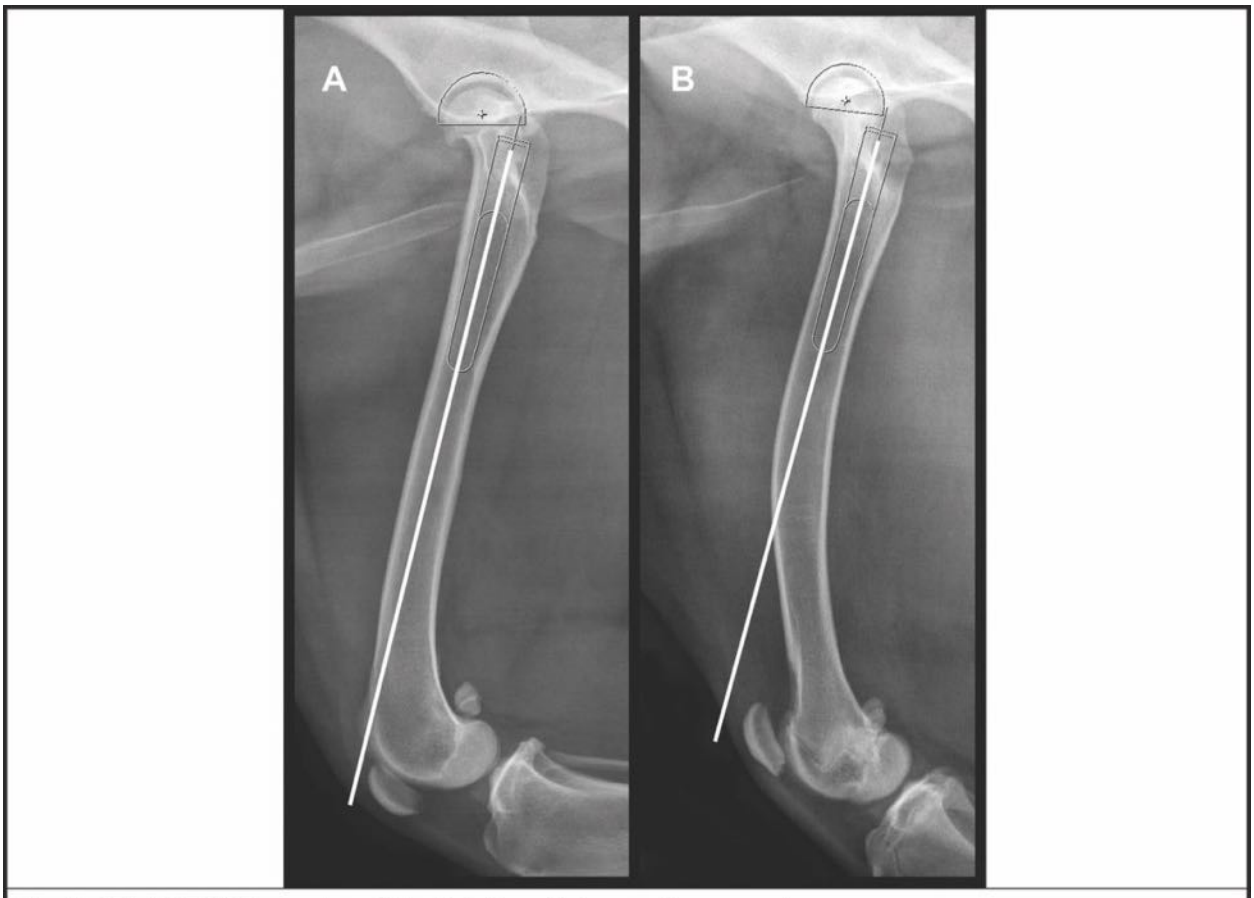


Fig 3-14 A & B Open-Leg Mediolateral Femur Procurvatum

CFX Femoral Implant Sizing

The templating process for the CFX and the BFX stems is the same except that space is allotted for a cement mantle. The level of the femoral osteotomy determines the depth a CFX stem is inserted. The CFX stems are collared, and at full insertion, the collar rests on the craniomedial cortical bone of the femur. The ideal cement mantle is 2-4 mm in width, evenly distributed around the implant. As a general rule, the correct CFX stem size will be 1 or 2 sizes smaller than the appropriate sized BFX stem. The craniocaudal and open-leg mediolateral views are used to confirm the implant size and available space for the cement mantle (Fig 3-15 & 3-16).

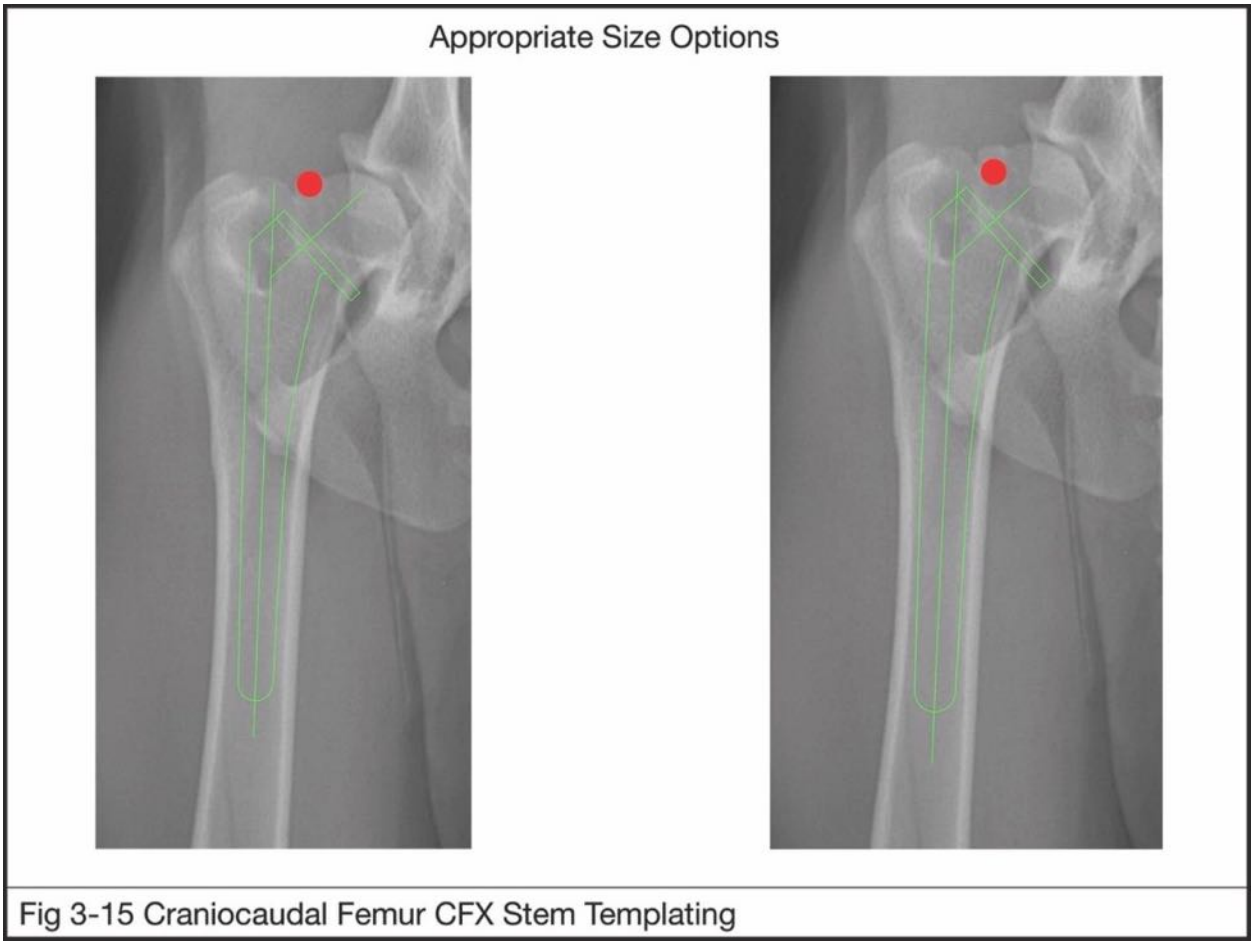


Fig 3-15 Craniocaudal Femur CFX Stem Templating

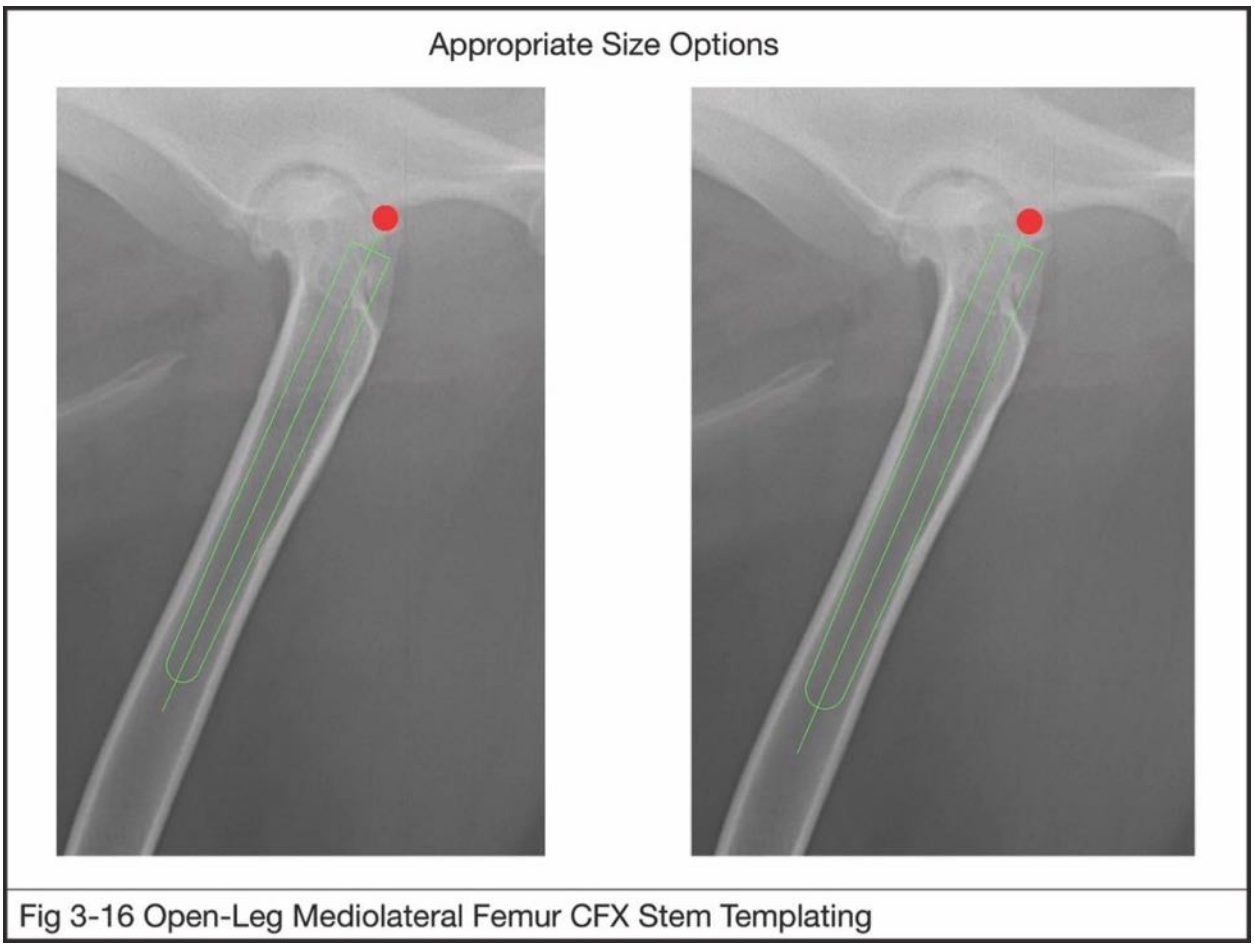


Fig 3-16 Open-Leg Mediolateral Femur CFX Stem Templating

Module 4 Reading: Patient Positioning

In the dysplastic hip, normal anatomic landmarks of the acetabulum may be absent, unreliable, and misleading. The BioMedtrix Canine Positioning Board allows you to reference from reliable anatomic landmarks during acetabular preparation and cup placement. For the novice surgeon, using the ilial and ischial posts of the Positioning Board as reference points can be helpful. The positioning device stabilizes the pelvis and prevents movement during muscle retraction, reaming, and cup impaction. If the patient is correctly positioned and secured in the **Positioning Board**, the device consistently maintains the pelvis in the correct position throughout the procedure. The device is equally useful for CFX or BFX implants and is crucial for setting the angle of the acetabular orientation during reaming and impaction of the BFX cup. Alternatively, a surgical beanbag can be used to position the patient in the same orientation on the surgical table, and in this case, you reference directly from the bony landmarks.

In both CFX and BFX hip replacement, the dorsal iliac spines and the ischiatic tuberosities serve as reference points. The dog's position on the operating table is crucial in determining the orientation of these landmarks and, hence, the final position of the acetabular component. The positioning device securely locks the pelvis in the correct orientation using three adjustable vertical columns (Fig 4-1). The correct position of the pelvis occurs when the two hemipelves are superimposed one over another so that a line drawn between the two ischial tuberosities is perpendicular to the ground when viewed from the rear of the dog. Also, the dog's pelvis must be parallel to the floor (cranial to caudal) and not running downhill as may happen in thin waisted dogs. If the ilial wings are lower than the ischial tuberosity, a towel or sandbag can be used to level the pelvis. Also, you must be sure that the tabletop is parallel to the floor and locked in place. Place one column of the Positioning Board dorsal to the dorsal iliac spines and one dorsal to the ischiatic tuberosities. The pelvis is securely held against the two dorsal columns by a third column in the ventral abdominal area. Since the two columns are in contact with and parallel to the anatomic reference points, the tops of the columns are used as reference points for the Positioning Board Alignment Guide during acetabular reaming and implantation of the cup.

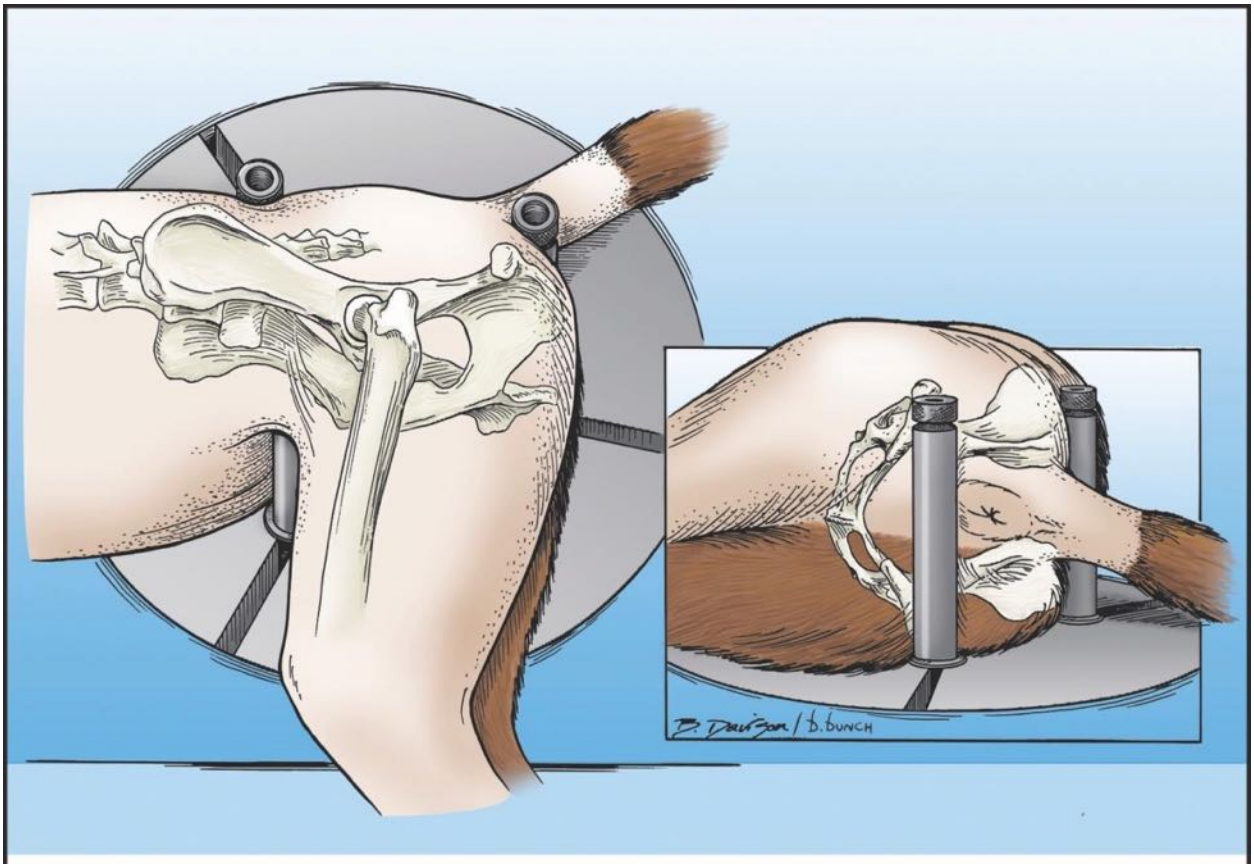


Fig 4-1 Positioning Board

Positioning the dog on the table with the dog's ventrum closer to the edge of the table will provide better access to the femoral canal during broaching. This positioning permits the limb to hang over the edge of the table, thereby elevating or aiming the proximal aspect of the femur out of the wound. When the femur is angled in a more upward direction, it provides better access into the femoral canal and allows the instruments to clear the gluteal muscles more easily. Also, the dog's pelvis should be positioned near the end of the table to allow close positioning of the instrument table.

In the prep room, the dog's anal sacs are expressed, and a purse-string suture is placed in the anus. The affected limb is prepped by removing the hair from cranial to the ilium along the dorsal midline of the spine to the base of the tail and caudal ischium, and circumferentially around the limb to below the tarsal joint (Fig 4-2). Several initial scrubs are applied in the prep room. The dog is placed on the Positioning Board in the operating room. Once the dog is positioned correctly and secured, the limb is elevated and the final surgical scrubs are applied. The final height of the dorsal columns is adjusted by the addition of sterile extensions placed immediately before draping the patient. Standard draping techniques are used, but care is taken to exclude the columns from the surgical field. If you decide to use the Positioning Board, it comes with detailed instructions.

https://www.youtube.com/watch?v=x9iGrEIYReI&list=TLGGuSB3YwqSM0IwODA4MjAyMg

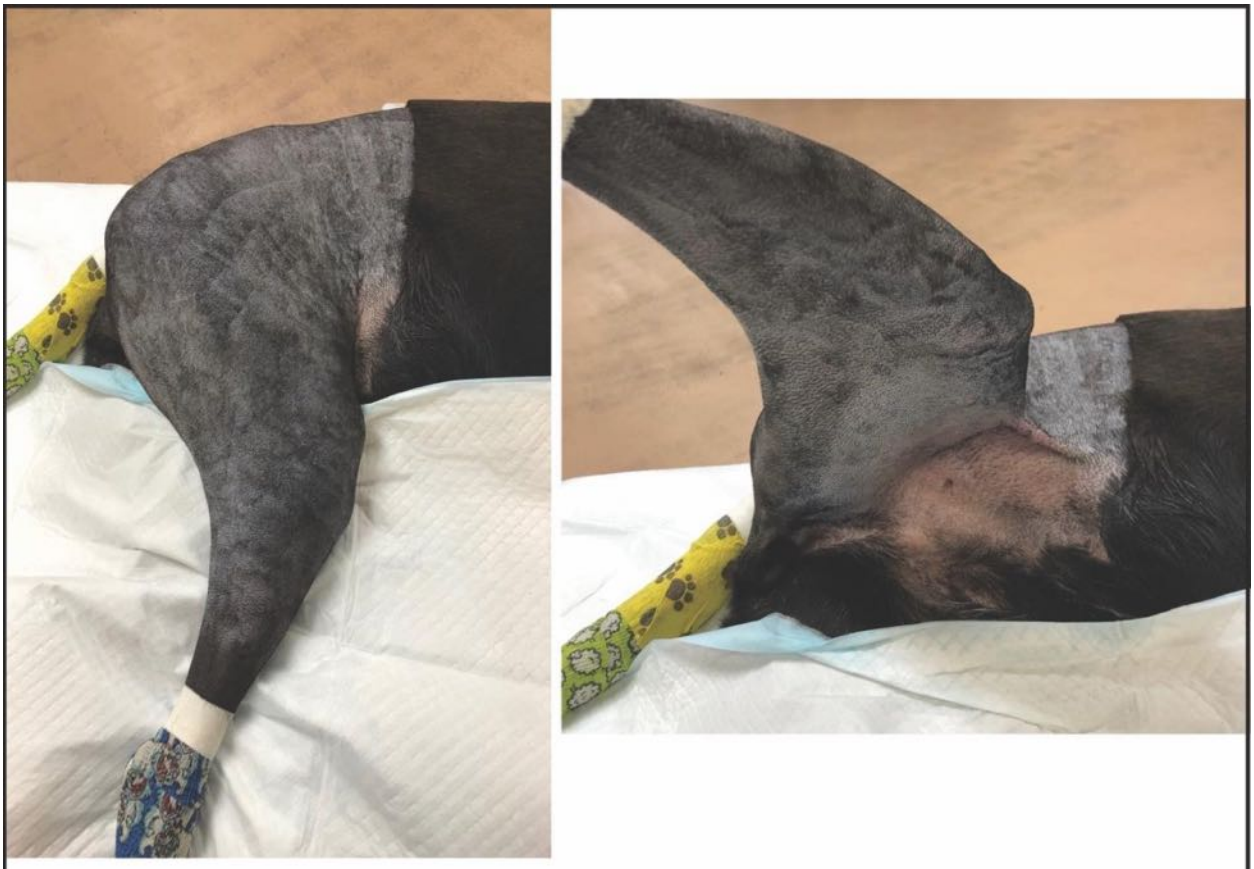


Fig 4-2 Patient Clip

Module 5 Reading: Surgical Approach, Exposure & Retraction

The hip joint is exposed using the cranial-lateral approach. This approach is frequently used for other hip procedures; however, for THR, you must take the time to sufficiently develop the approach to provide excellent exposure and access to the proximal femur and the acetabulum. The importance of this step is often underestimated. Attention to hemostasis is essential to provide a clear field of vision.

The skin incision is made just cranial to the greater trochanter with approximately one-third of the incision above the trochanter and two thirds below. The dorsal portion of the incision from the greater trochanter proximally is curved slightly caudally to allow better visualization and access to the femoral canal. This is most important in obese dogs or heavily muscled breeds like the Rottweiler. The subcutaneous tissues are then incised along the same line exposing the biceps fascia and its junction with the cranial border of the biceps femoris muscle (Fig 5-1). Incise between the biceps fascia and the cranial edge of the bicep's femoris muscle the length of

the incision. This will expose the next layer of tissues composed of the superficial gluteal muscle, the tensor fascia lata muscle, and the fascia lata. An incision is made separating the fascia lata from the tensor fascia muscle and extended dorsally and curving cranial between the tensor fascia muscle and the superficial gluteal muscle (Fig 5-2).

The separation and retraction of this superficial layer of tissues will expose the underlying vastus lateralis muscle and the middle gluteal muscle. Bluntly dissect under the middle gluteal muscle staying close to its insertion on the greater trochanter to expose the deep gluteal muscle and its tendon. Place an Army-Navy retractor under the middle gluteal muscle and retract the muscle dorsally to expose the deep gluteal muscle and its tendon inserting on the femur. This is followed by undermining the tendon of the deep gluteal muscle from the underlying joint capsule up to its insertion on the femur. Cleaning up and isolating the tendon insertion makes it easier to transect the tendon at the appropriate point and in the correct direction. Transect the tendon parallel to its insertion on the femur, leaving a portion of the tendon on each side of the transection to hold sutures during closure (Fig 5-3). Once the tendon of insertion of the deep gluteal muscle is partially transected near its insertion on the femur, the muscle belly is divided longitudinally. The ventral two-thirds of the deep gluteal muscle is reflected cranial-dorsal to expose the underlying joint capsule and common origin of the vastus lateralis and vastus intermedius muscles. An Army-Navy retractor is used to retract the remaining intact gluteal muscle dorsally to expose the joint capsule further.

Incise the joint capsule parallel to the axis of the femoral neck. For the right hip, this is at 2 o'clock and 10 o'clock for a left hip. The incision extends from the labrum of the acetabulum across the origin of the vastus intermedius and vastus lateralis muscles to expose the femoral neck and the femoral metaphysis. The ligament of the head of the femur is cut using a Hatt Spoon/Bone Curette or a similar device (Fig 5-4). The femoral head is dislocated from the acetabulum by simultaneously levering the femoral head (using the Hatt Spoon) out of the acetabulum and forcefully externally rotating the femur 90 -130 degrees. The femoral neck area is further exposed by elevating the vastus lateralis and vastus intermedius muscles from within the joint capsule, using a large periosteal elevator to expose the site where the femoral neck joins the femoral metaphysis (Fig 5-5). The acetabulum is exposed following the femoral neck osteotomy.

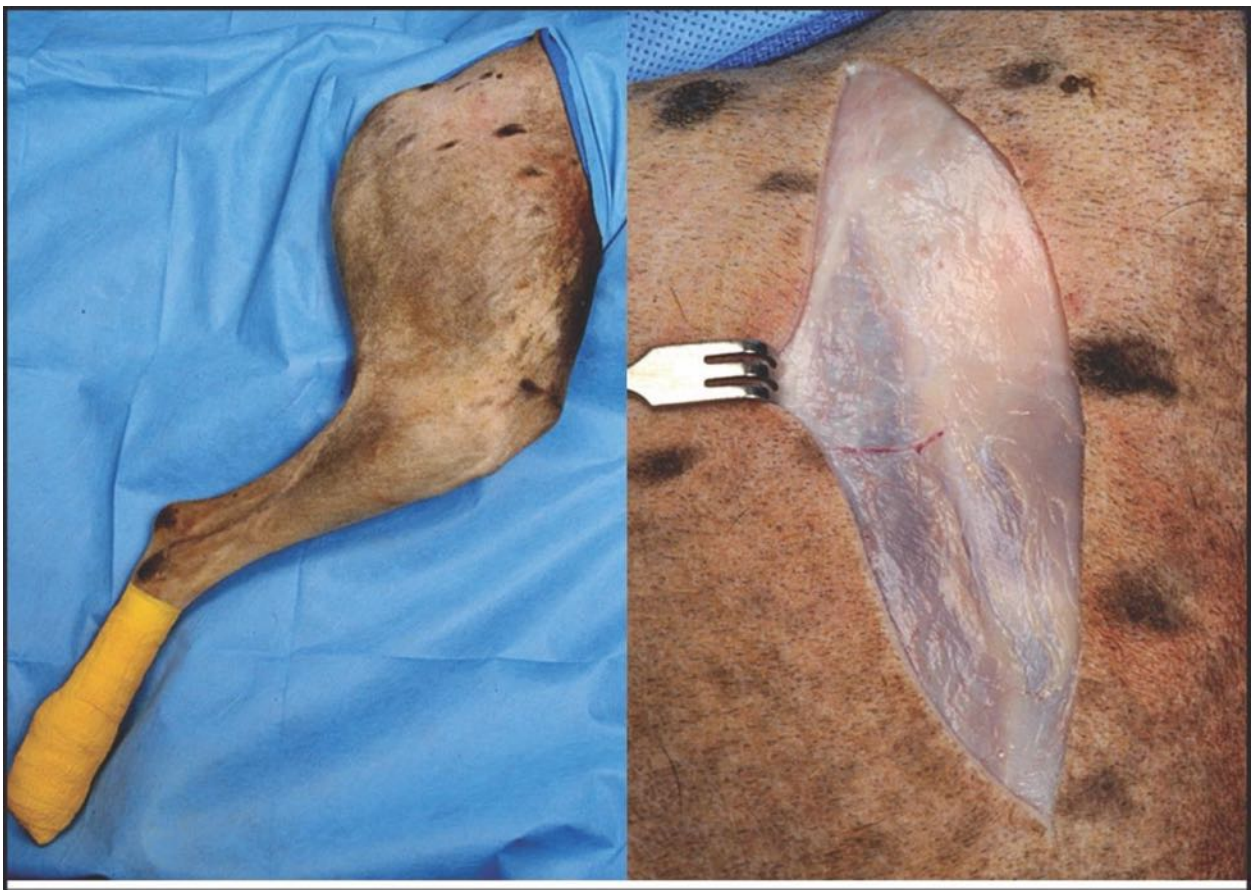
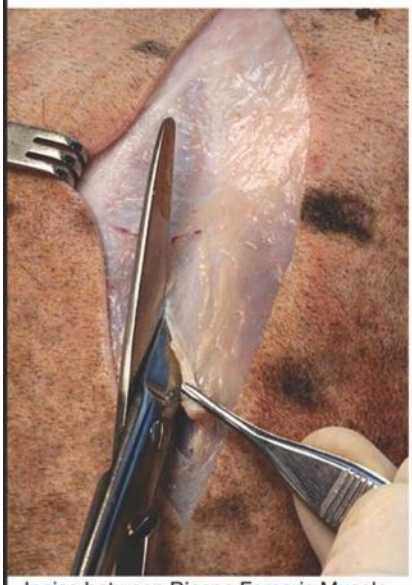
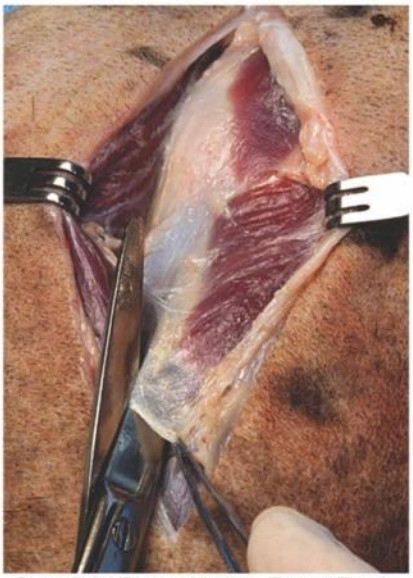


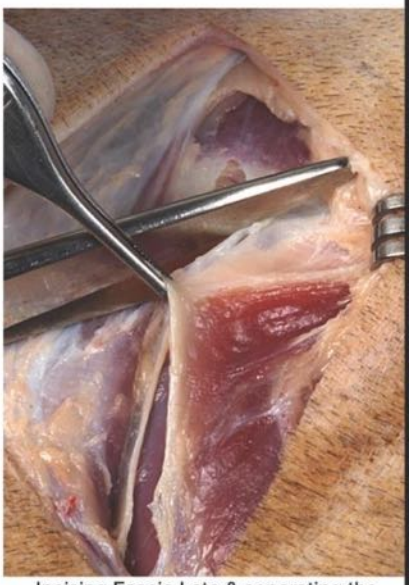
Fig 5-1 Right Hind Limb Skin Incision



Incise between Biceps Femoris Muscle and Biceps Fascia

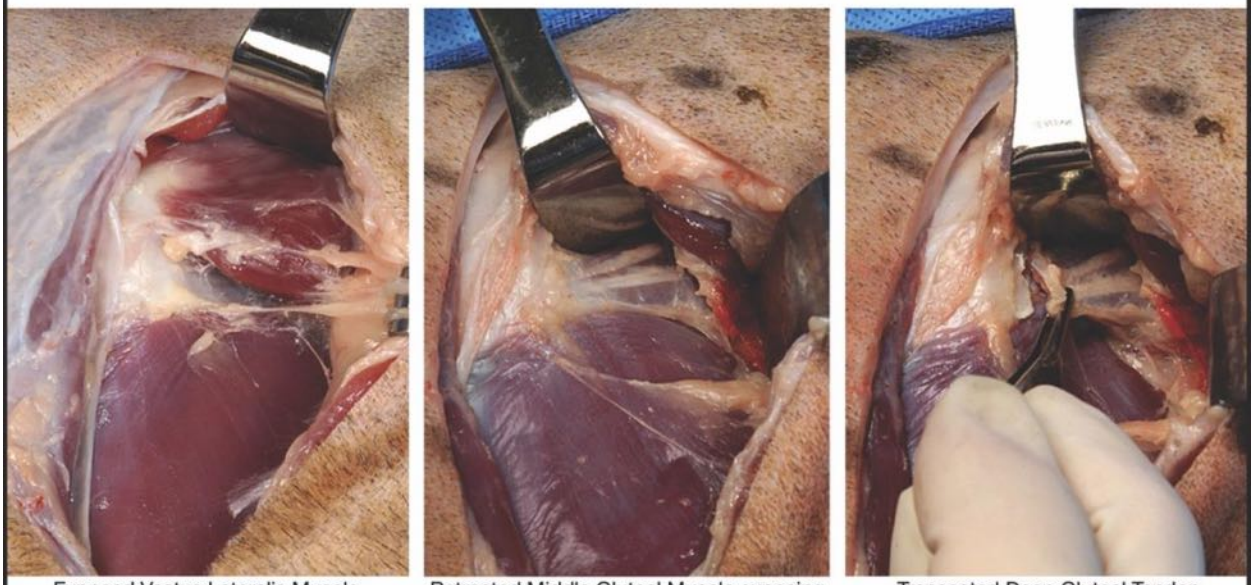


Superficial Gluteal Muscle, Tensor Fascia Lata Muscle & Fascia Lata



Incising Fascia Lata & separating the Tensor Fascia Muscle from Superficial Gluteal Muscle

Fig 5-2 Superficial Muscle Layers



Exposed Vastus Lateralis Muscle and Middle Gluteal Muscle

Retracted Middle Gluteal Muscle exposing the Deep Gluteal Muscle & Tendon

Transected Deep Gluteal Tendon

Fig 5-3 Deep Muscle Layers

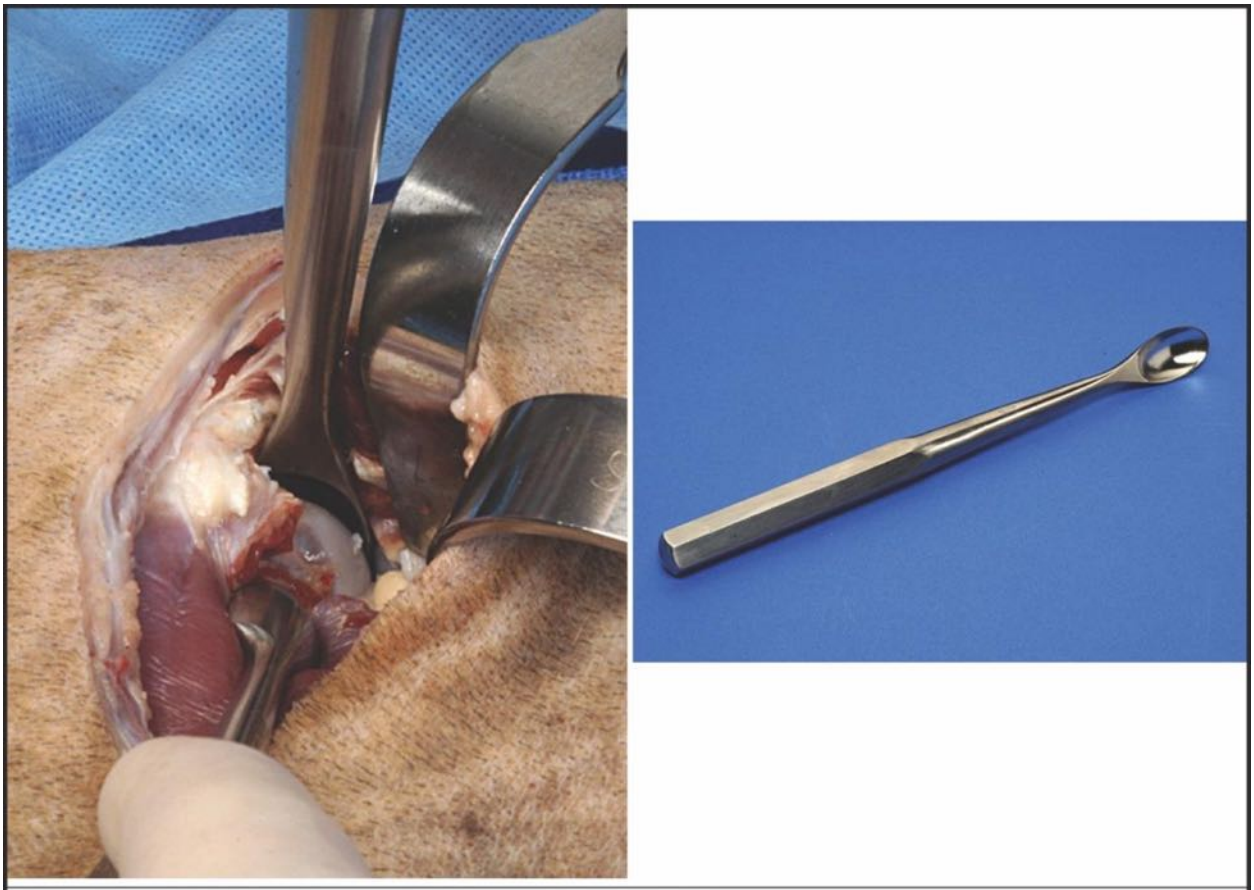


Fig 5-4 Severing Ligament of Femoral Head with Hatt Spoon

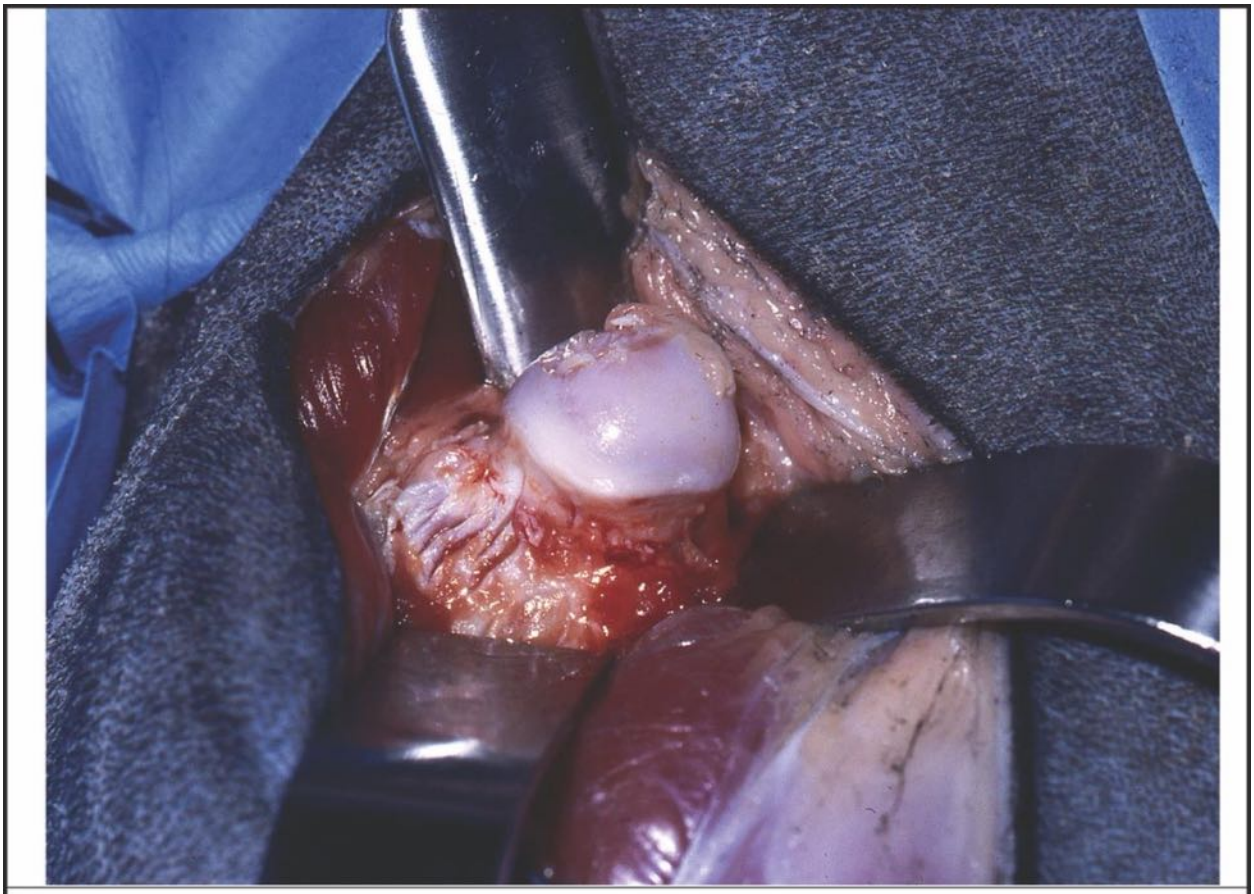
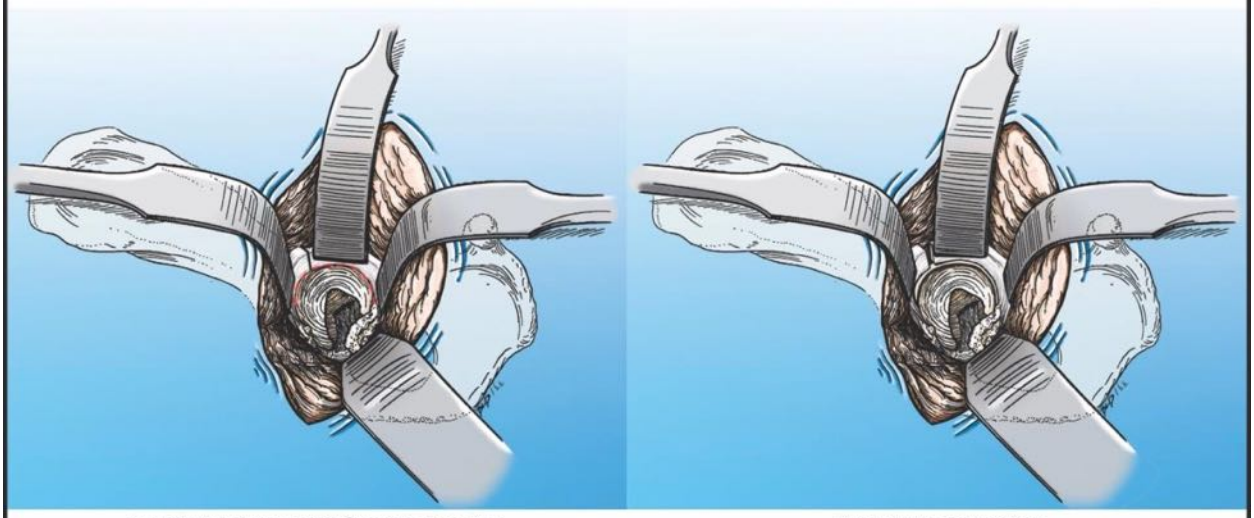


Fig 5-5 Exposed Femoral Neck

Implantation of the cup requires an unobstructed view and access to the acetabulum for reaming and impaction of the cup. If the proximal end of the femur is in the way, it may be necessary to try to externally rotate the femur again while levering the femoral head to breakdown additional fibrous tissue surrounding the joint. The exposure of the acetabulum is dependent on dorsal retraction of the capsule and gluteal muscles and caudal retraction of the proximal portion of the femur. In patients with chronic dysplastic changes, the junction of the joint capsule and the bony acetabular rim must be identified to distinguish between what is bone and what is fibrous tissue. Often a tough fibrous joint capsule can be undermined 2-3 mm with a scalpel blade around the circumference of the acetabulum. Meyerding retractors are then positioned under the reflected joint capsule cranial and dorsal to the acetabulum (Fig 5-6). Placing the retractors under the fibrous joint capsule decreases the trauma resulting from retraction. With the femur in a normal walking position, the caudal Meyerding retractor can be placed on the proximal aspect of the femur and retracted caudally to expose the acetabulum. Alternatively, a Hohmann retractor can be carefully positioned caudal to the acetabulum and used to retract the femur. Avoid excessive force on the Hohmann retractor to prevent fracturing the caudal acetabulum, or damage to the sciatic nerve as it passes over the ischium just caudal to the acetabulum. During preparation of the femur, a large blunt tip Hohmann retractor is used to elevate the proximal aspect of the

femur from the wound during femoral broaching (Fig 5-7). The femur is freed to allow external rotation to 90 degrees, and the metaphysis free to be elevated out of the wound to allow unhindered access to the femoral canal.



Acetabular Bone-Joint Capsule Junction

Acetabular Retraction

Fig 5-6 Acetabular Bone-Joint Capsule Junction and Acetabular Retraction

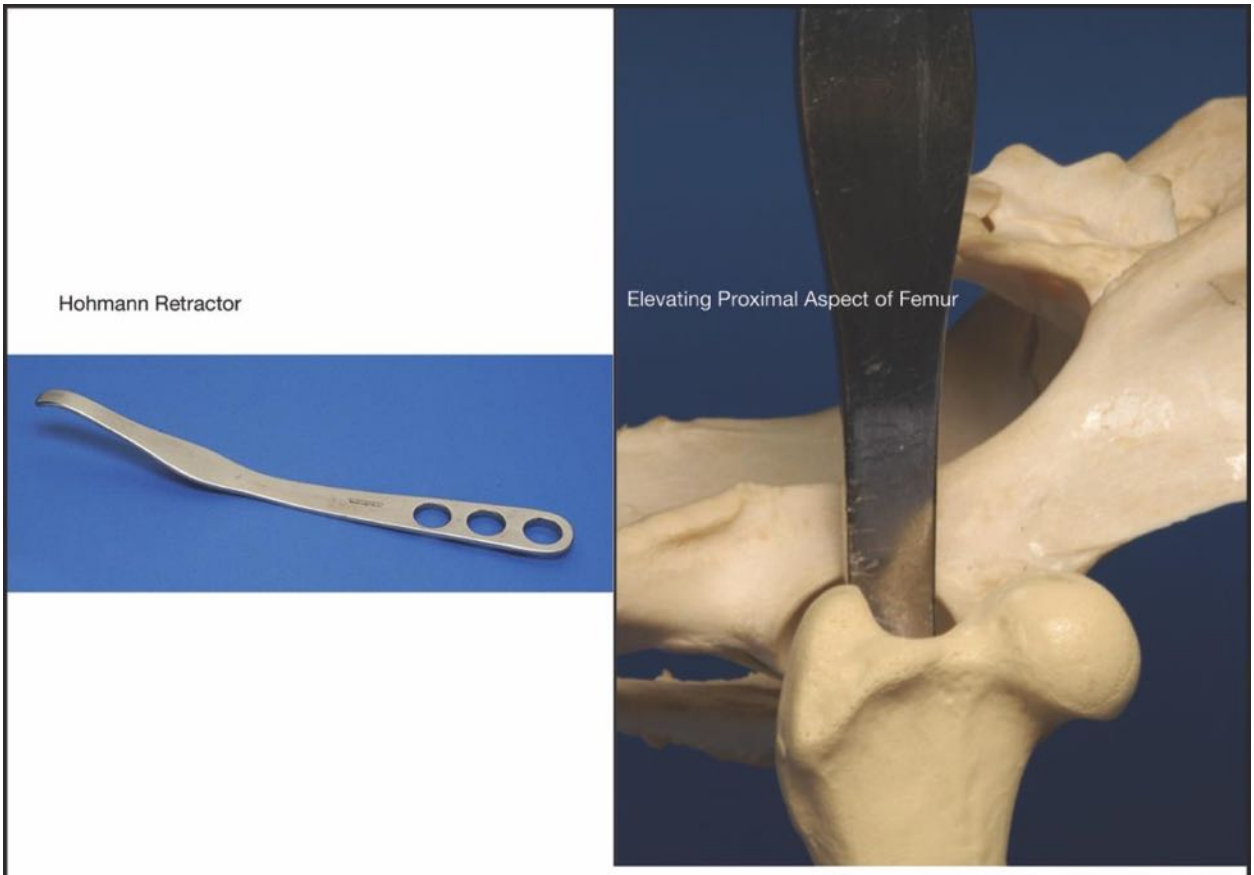


Fig 5-7 Femoral Elevation

Before moving on to the implantation part of the procedure, it is always best to take a few minutes to assess and fully develop the exposure of the acetabulum and confirm that you can adequately rotate the femur 90 degrees, so the patella is pointing up. Also, confirm that you can elevate the proximal portion of the femur so that you have unhindered access to the femoral canal. It is important to remember that inadequate exposure can lead to frustration, complications, and an unfavorable outcome. Often during the heat of the moment, one tends to continue rather than stepping back to improve the exposure. Another tip to aid in the exposure of the femur is to position the patient closer to the surgeon's side of the table. This allows the limb to hang over the edge of the table when externally rotated, and pressure can then be applied downward on the stifle joint. This downward pressure elevates or aims the proximal aspect of the femur out of the wound to provide better access to the femoral canal. Also, when positioning the patient, take care not to build the beanbag positioner too high under the patient's leg, as this may impede pushing down on the stifle joint. Similarly, when using the Positioning Board, the post located under the limb may interfere with your assistant's ability to push down on the stifle joint. Usually, this can be alleviated by moving the femur slightly caudal, so it is not centered over the post.

Module 6 Reading: Neck Resection

The femur is rotated externally 90 degrees to expose the femoral head and neck, then held in this position during the neck resection. The medial edge of the most dorsal portion of the greater trochanter is identified. Align the Neck Resection Template with the central axis of the femur similarly to when you placed the template over the radiograph of the proximal portion of the femur. If severe remodeling of the femoral head hinders positioning of the resection guide, the osteophytes at the base of the femoral head that cover the cranial cortex of the femoral neck are removed using a large rongeur (Fig 6-1 & 6-2). The femoral neck resection is made parallel to the cutting guide using the medial edge of the top of the greater trochanter as a reference point. The saw blade is held perpendicular to the cranial surface of the femoral metaphysis (Fig 6-3 & 6-4). The neck resection is identical for both the collared CFX and the collarless BFX stems. A high osteotomy is made to preserve proximal cancellous and cortical bone and to enhance stability and torsional resistance of the implanted stem. Do not lower the neck resection level to improve access to the central axis of the femoral canal. The osteotomy site is not used to access the femoral canal, rather the canal is entered through the trochanteric fossa.

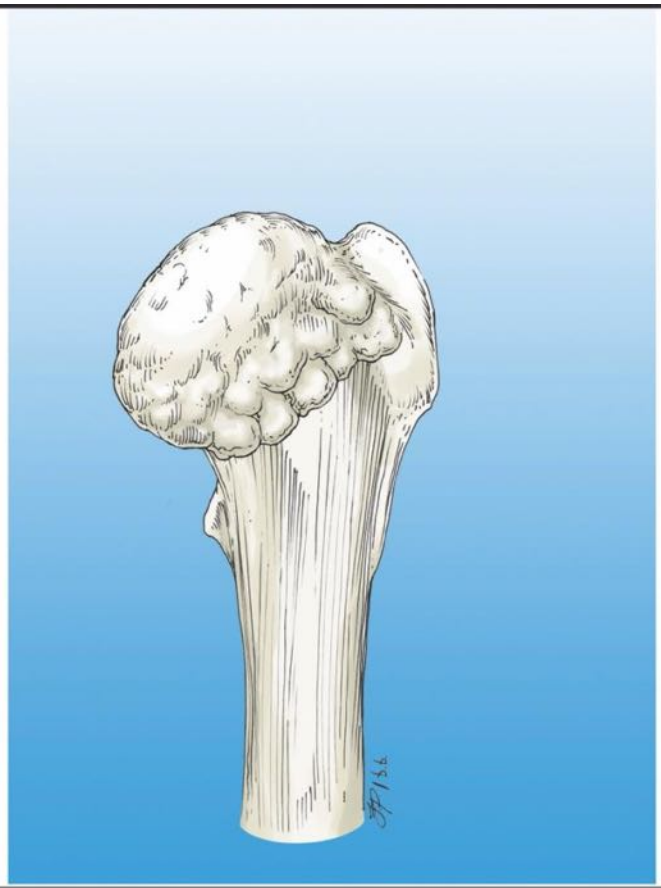


Fig 6-1 Femoral Head Osteophytes

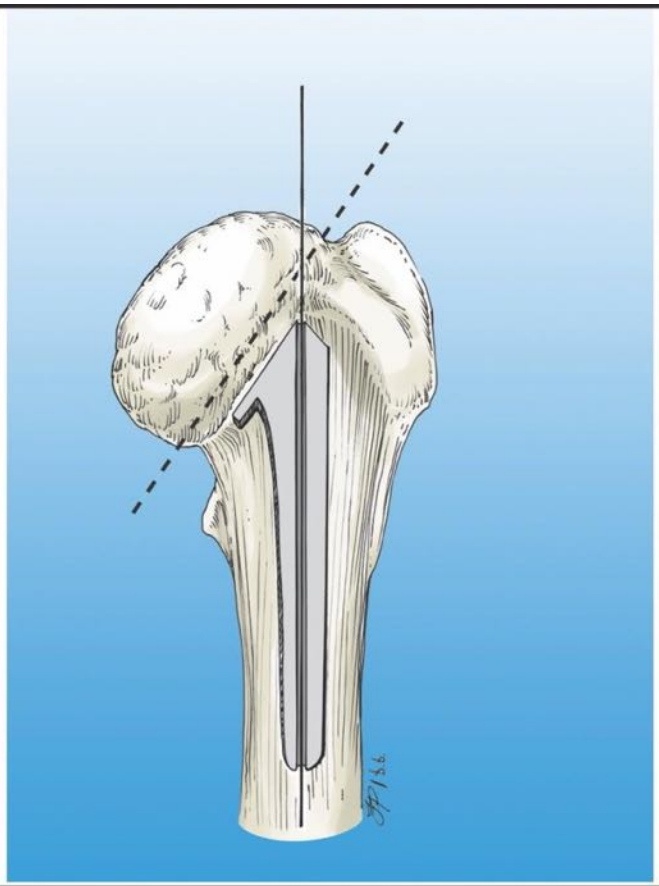


Fig 6-2 Femoral Osteophyes Removed with Neck Resection Template

Fig 6-3 Saw Blade Perpendicular to Cranial Surface of the Femoral Metaphysis

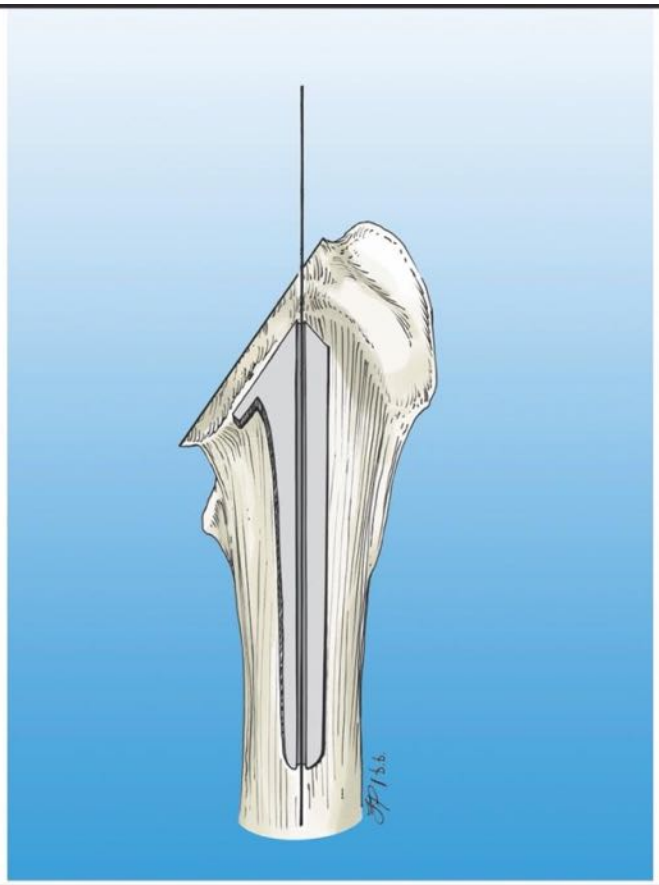


Fig 6-4 Femoral Head and Neck Removed

An alternative instrument, the Neck Resection Guide is available with an alignment rod that references from the patella. This guide helps improve the accuracy of the neck cut angle. The angle of the neck cut is most important when using a collared CFX stem. When the collar is seated against the neck cut it sets the axial alignment of the stem in the canal. Because the standard BFX stem is collarless, the neck resection angle is less critical. It is recommended that regardless of the implant being used, always strive to make the cut correctly, as the choice of implants may change during the procedure.

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Module 7 Reading: Acetabular Preparation

Preparation of the acetabulum requires an unobstructed view and access to the acetabulum for both reaming the bone bed and insertion of the cup. The retractors are positioned where they do not interfere with or contact the reamers while reaming or with the cup during impaction. In advanced cases of hip dysplasia, identification and isolation of the bony labrum of the acetabulum are critically important. The bony rim of the acetabulum, especially cranially and caudally, is used to judge the depth of the reamed bone bed and the depth or level to which the cup is seated. The outer 3mm of the cup must be seated into the rim of the acetabular bone bed cranially and caudally to ensure press fit. If the bony labrum is not identified, the outer 3 mm of the cup may inadvertently be placed in the fibrous joint capsule and press-fit will not be achieved.

Before reaming, reliable reference landmarks must be identified. These landmarks are the cranial and caudal poles of the acetabulum, and the transverse acetabular ligament ventrally. Any large osteophytes are removed, especially ventrally and caudally, to facilitate positioning of the reamer, insertion of the cup, and improve the range of motion of the prosthetic joint. Also, removal of ventral osteophytes may aid in locating the transverse acetabular ligament. A ridge of osteophytes caudally can act as a fulcrum, promoting dislocation of the joint on external rotation. Finally, the acetabulum is reamed to create a hemispherical bone bed free of cartilage, eburnated bone, and fibrous tissue.

It is crucial to ream the true acetabulum and not a dorsally migrated false acetabulum resulting from chronic dorsal subluxation. In advanced stages of hip dysplasia, the acetabulum may be migrated dorsally and shaped like a large shallow saucer consisting of hard eburnated bone (Fig 7-1). This condition is referred to as saucerization of the acetabulum. In this case, the location of the true acetabulum must be identified before reaming. The ventral aspect of the original acetabulum is determined by locating the transverse acetabular ligament. The ventral edge of the desired final size reamer is maintained just dorsal to this landmark. A smaller starter reamer is used to create a shallow dimple in the desired location of the center of reaming. The bone bed is expanded to the outer rim of the saucerized acetabulum using sequentially larger starter reamers. Once the desired diameter and depth has been established, the final preparation is accomplished with the Finishing Reamer. If too small a diameter cup is implanted in the middle of the saucer, the face of the cup may be below the outer rim of the concave acetabulum, resulting in a fulcrum effect and dislocation.

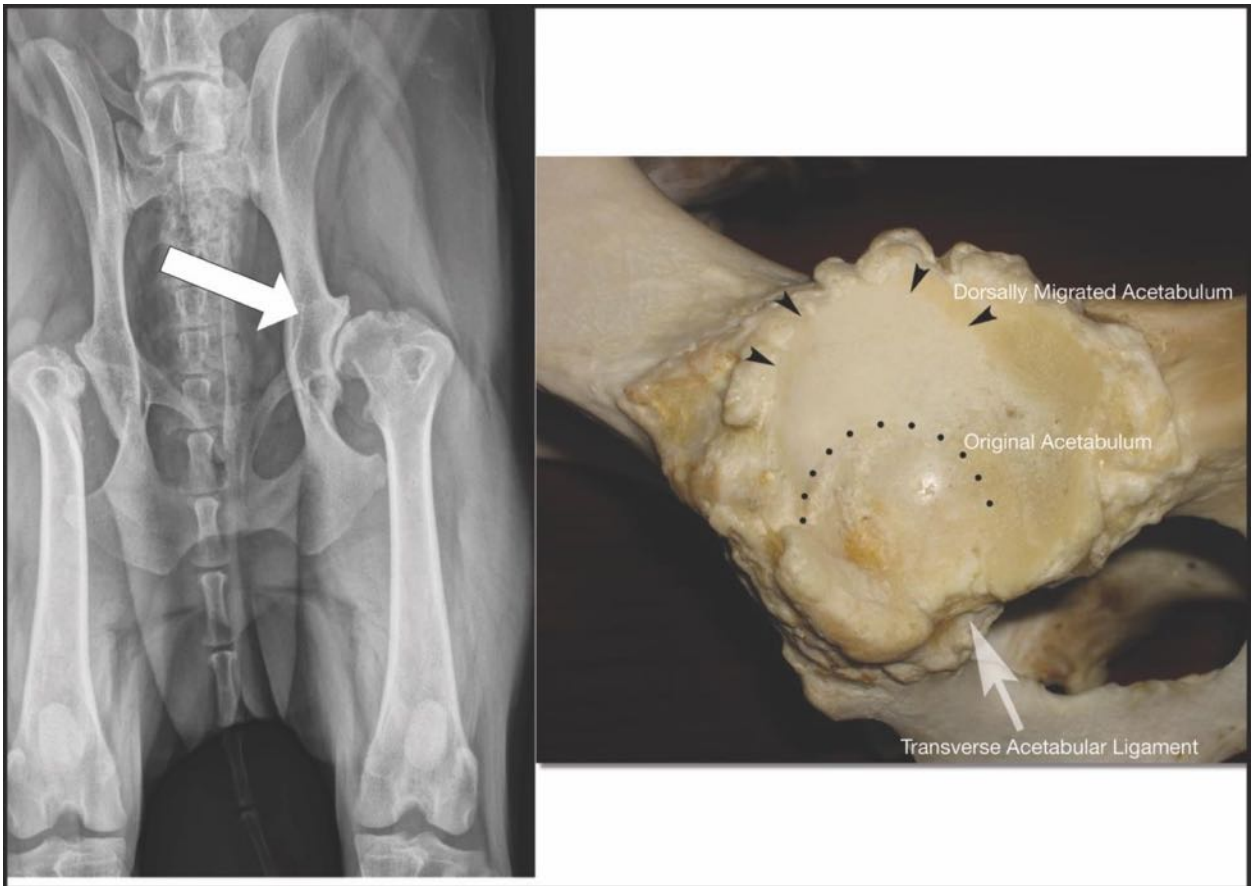


Fig 7-1 Shallow Saucer Shaped Acetabulum

To prevent removal of the dorsal rim and to prevent dorsal migration of the reamer, reaming is started with the reamer shaft directed at an angle approximately 15-20 degrees ventral to perpendicular (Fig 7-2A), rather than at the 45-degree anatomic axis of the acetabulum (Fig 7-2B). This angle is maintained until at least 50- 75% of the full reaming depth has been achieved before lowering the reamer shaft to the anatomic axis. Positioning the reamer shaft at the 45-degree angle before gaining at least 50% of the full depth will result in removal of the dorsal rim and migrate the preparation dorsally. Remember, the starter reamer is a hemisphere, and the angle of the initial ream does not affect the final orientation of the Finishing Reamer or the cup. It is important to prevent dorsal bone removal and hold the reamer firmly to avoid violating the bony envelop created by the reamer. All reaming is done with the reamer shaft positioned in 25 degrees of retroversion (Fig 7-2C).

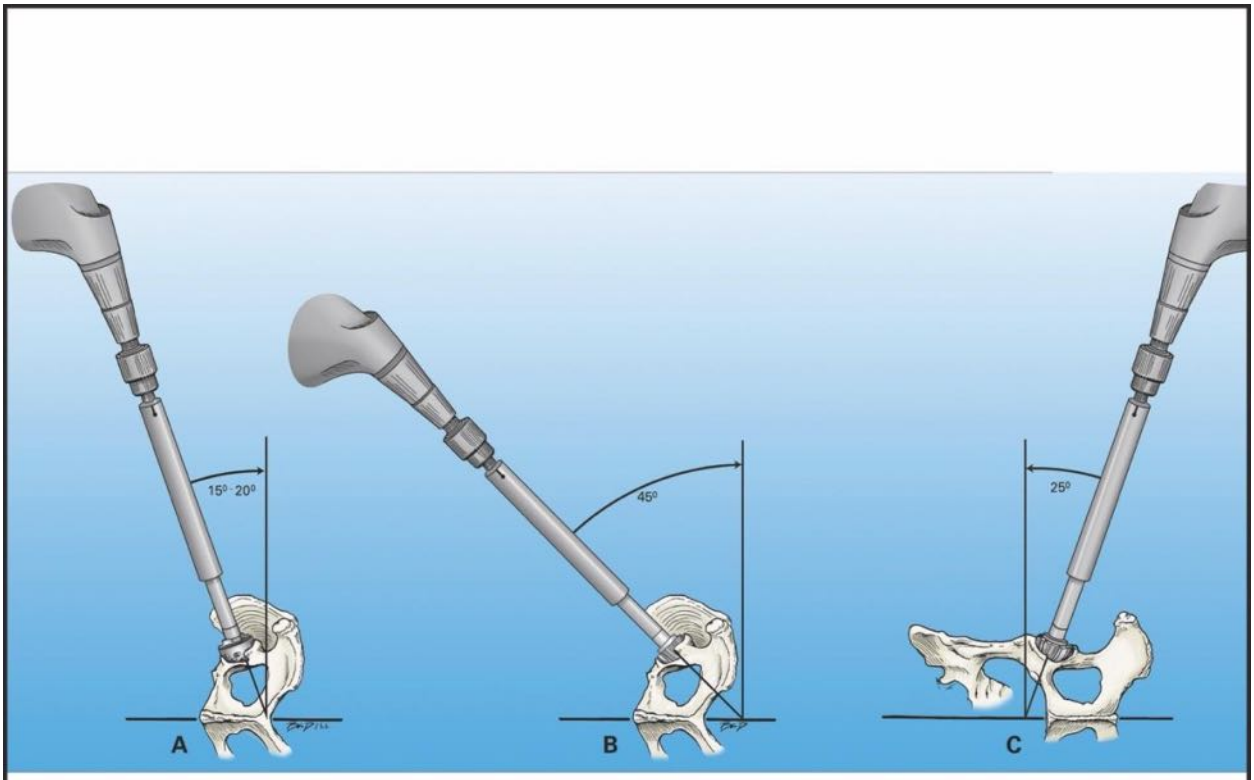


Fig 7-2 A, B & C Acetabular Reaming Angles

Cup Orientation Terminology

Angle of Lateral Opening - As viewed from the surgeon's perspective, is the angle formed between a line drawn perpendicular to the transverse axis of the dog's pelvis and a line drawn through the central axis of the cup. The standard angle of lateral opening is **45 degrees**. It is a major contributing factor in dislocation.

Angle of Retroversion- The degree of version is the angle formed between a line drawn perpendicular to the surgery table (transverse plane) and a line through the central axis of the cup. When the central axis (or face) of the cup is directed caudally it is retroverted. When the central axis is directed cranially, it is anteverted. When the central axis is at 90 degrees to the transverse axis of the pelvis, the component is said to be in normoversion. The standard degree of retroversion is **25 degrees.** The angle of retroversion of the cup and the angle of anteversion of the femoral neck ideally are aligned. Both are contributing factors to dislocation.

Angle of Inclination- The angle of inclination of the cup, is the angle created by a line drawn through the truncation of the cup and a line drawn through the ilial-ischial axis. The

standard angle of inclination of the cup is approximately **20 degrees** ventral to the ilial-ischial axis.

Intraoperatively, the alignment guides align the reamer shaft and the impactor handle in 45 degrees of lateral opening and 25 degrees of retroversion. The angle created by the alignment guides is a compound angle, and cannot be equated with the angle of retroversion measured from a VD radiograph postoperatively. The radiograph is a 2-dimensional image made of a 3-dimensional object in space. Errors in patient positioning during surgery and radiographic positioning can also contribute to the difference between the intraoperative and the radiographic angles. **Therefore, when we refer to placing the reamer or cup impactor in 25 degrees of retroversion, it is not the same as the degree of retroversion of the cup as viewed on the VD radiograph.**

The cup is oriented in three different planes, and two are guided by the instrumentation: The angle of lateral opening at 45 degrees, and the angle of retroversion at 25 degrees. The angle of inclination results from rotating the cup mounted on the impactor handle around its central axis until the cranial and caudal poles of the cup align with the cranial and caudal bone columns of the acetabulum. Consequently, the angle of inclination of the cup matches the angle of inclination of the dog's acetabulum. The angle of inclination is not taken into consideration during reaming of the bone bed, only during seating of the cup. The standard angle of inclination of the cup is approximately **20** degrees ventral to the ilial-ischial axis. The alignment guides were designed to provide reproducible acetabular bone bed preparation and cup positioning. It is imperative to follow the angles set by the guides, especially when normal acetabular anatomy is not visible because of remodeling changes associated with hip dysplasia.

To minimize deviation of the reamer or wobbling, the surgeon must hold the reamer motionless and directed at the correct angle. Holding the power reamer in one hand, and the reamer shaft with the other aids in stabilizing the reamer. The rotating reamer shaft is covered with a nylon sleeve that allows you to grip the shaft. Following the initial reaming from a vertical angle, position the reamer in the correct anatomic angle as determined by the reaming alignment guides. The reamer is held steady by firmly anchoring your arms to your sides and spacing your feet at least a shoulder's width apart to minimize movement. Adjusting the table lower than one may be accustomed to facilitates accurate reaming by bringing your elbows close to your sides. The reamer shaft is held stationary as the depth and diameter of the bone bed are expanded. Acetabular reaming must be deliberate and accurate to ensure proper alignment and press-fit. Accurate reaming is facilitated by using a low-speed, high-torque power reamer.

Preparation of an accurate acetabular bone bed is accomplished using a two-stage reaming technique. First, a Starter Reamer ("cheese grater" style) 1 mm smaller than the intended BFX cup is used to establish the depth of the bone bed. Second, a solid core Finishing Reamer the same size as the BFX cup, is used to expand the diameter of the bone bed to achieve an accurate preparation within the required tolerance for a press-fit. Recall from Module 2 that there is a 1mm difference in diameter between the Starter Reamer and the solid core Finishing Reamer.

Some surgeons prefer to start reaming with a starter reamer two sizes smaller and sequentially ream up to the intended size, followed by the appropriate finishing reamer. The Starter Reamer is used initially to create the depth because of its ability to remove cartilage and penetrate hard subchondral bone. The hollow reamer head also collects cancellous bone that can be used later in the procedure for a bone graft if needed. However, "cheese grater" style reamers tend to deform with use and are difficult to manufacture to the specifications required for a press-fit cup. The solid core Finishing Reamer offers the advantage of being accurately manufactured, maintaining its shape during use, and reaming smoothly without chatter once an initial bone bed has been established. The Finishing Reamer was designed to expand the bone bed in diameter only. It will not add additional depth to the reamed bone bed. Once the acetabular bone bed has been prepared and you decide to use the next largest BFX or CFX cup, the bone bed must be reamed first with the next size Starter Reamer and completed with the appropriate size Finishing Reamer. **If the Starter Reamer is not used to increase the depth of the preparation, the rim of the BFX cup will not seat nor achieve press-fit stability, and the bed will not be deep enough for the CFX cup.** The Starter Reamers are odd-numbered (19, 21, 23, 25, 27, 29, 31, 33 mm) and the Finishing Reamers are even-numbered sizes (20, 22, 24, 26, 28, 30, 32, 34 mm). Generally, reaming is started with a Starter Reamer 1-2 sizes smaller than the desired end size. If a 26 mm BFX cup is to be placed, the reaming is initiated with a 23 or 25 mm Starter Reamer, then completed with the 26 mm Finishing Reamer. The CFX cups are the same size as the Starter Reamers and the BFX cups are the same size as the Finishing Reamers. The CFX cup is 1 mm smaller than the Finishing Reamer to allow for a cement mantle.

BFX Cup - Reamer Relationship

Finishing Reamers create a hemispherical bone preparation to the equator of the reamer, and then a secondary cylindrical preparation for 3 mm past the equator. The cylindrical portion of the reamed bed sets the orientation of the cup and must be carried out at the correct anatomic angle. The last 3 mm cylindrical portion of the ream does not allow the reamer or the cup to swivel in the bone bed as it does in the hemispherical portion of the preparation. Consequently, once the reamer or the cup is seated into the cylindrical portion, the orientation is set. The geometry of the BFX cup is congruent with the Finishing Reamer to achieve a press-fit.

The cup has three (3) zones:

1. Hemispherical dome (line fit with Finishing Reamer)
2. Graduated hemispherical locking zone
3. Cylindrical locking zone beyond the equator of the cup

Figure 7-3 illustrates the geometry of the Finishing Reamer. Figure 7-4 represents the relationship of the cup to the reamed bone bed. The graduated hemispherical locking zone gets tighter the further the cup is impacted. The difference between the diameter of the Finishing Reamer and the cup is .5mm per side at the equator.

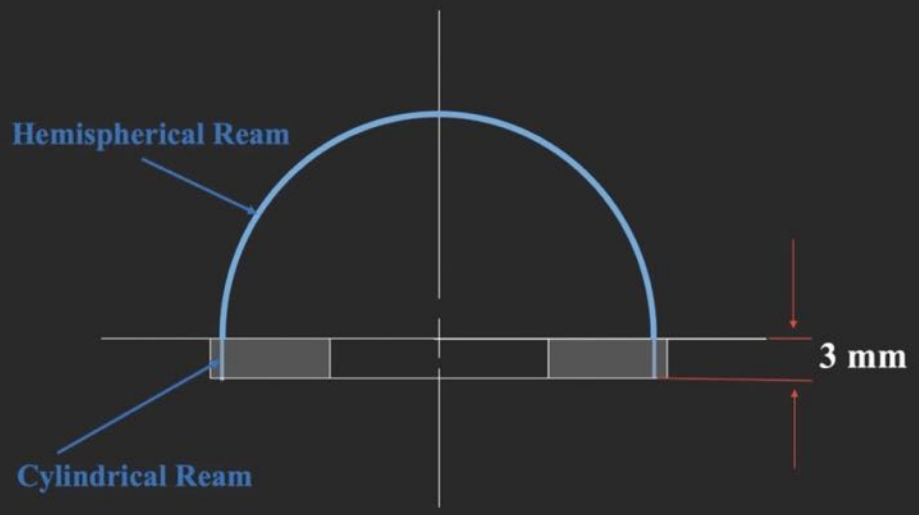


Fig 7-3 Finishing Reamer

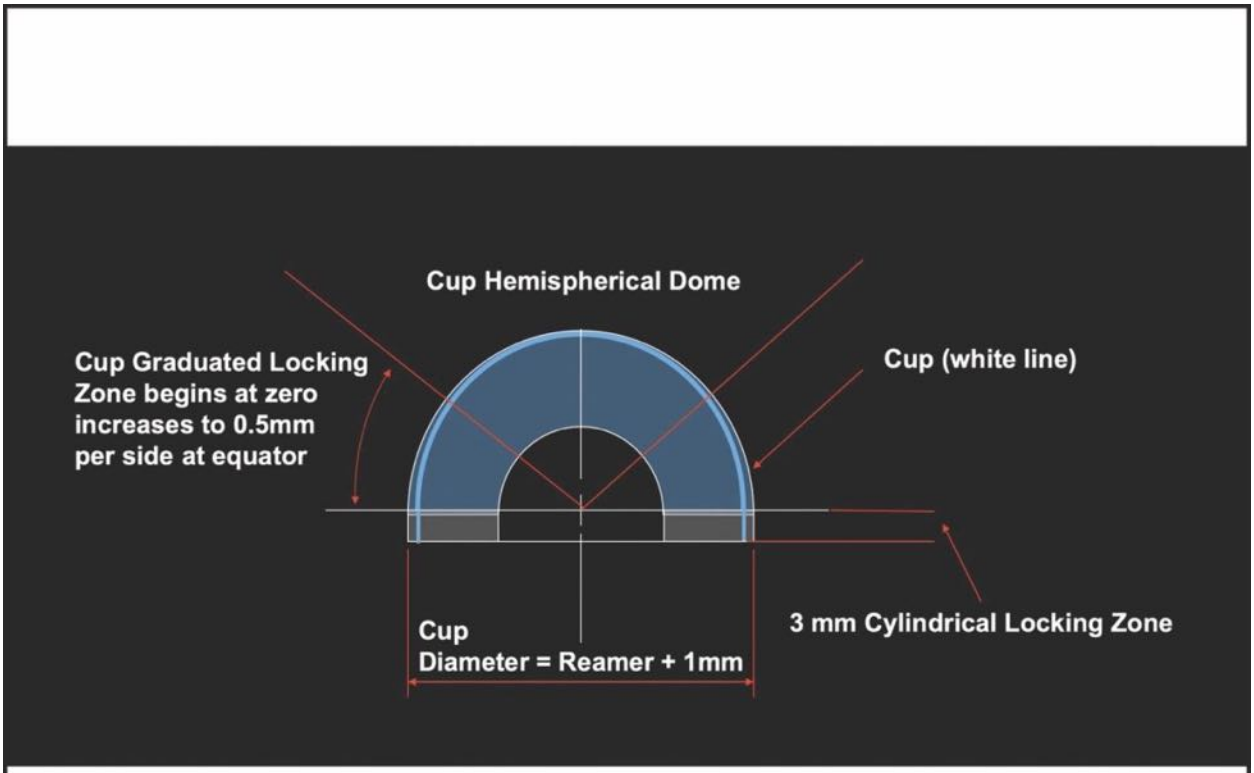


Fig 7-4 Finishing Reamer to Cup Relationship

Both the Starter and Finishing reamer heads are the same depth as the corresponding CFX and BFX cup and are used to determine the depth of the reamed bed (Fig 7-5). The best anatomic indicators for depth are the cranial and caudal aspects of the acetabulum. The cranial and caudal bone columns of the acetabulum are where the most stability for press-fit is achieved. Because the reamer is a full circle and the cup is truncated, it is impossible to judge the depth of the ream dorsally. Also, the dorsal rim is frequently worn away, providing a poor anatomic reference. In general, reaming is to the depth of the medial wall, but occasionally adequate depth is achieved before reaching the medial wall. In those cases, care should be taken to avoid placing the cup too deep or medialized as this can reduce joint reduction tension and result in impingement and possible dislocation on external rotation of the prosthetic joint.

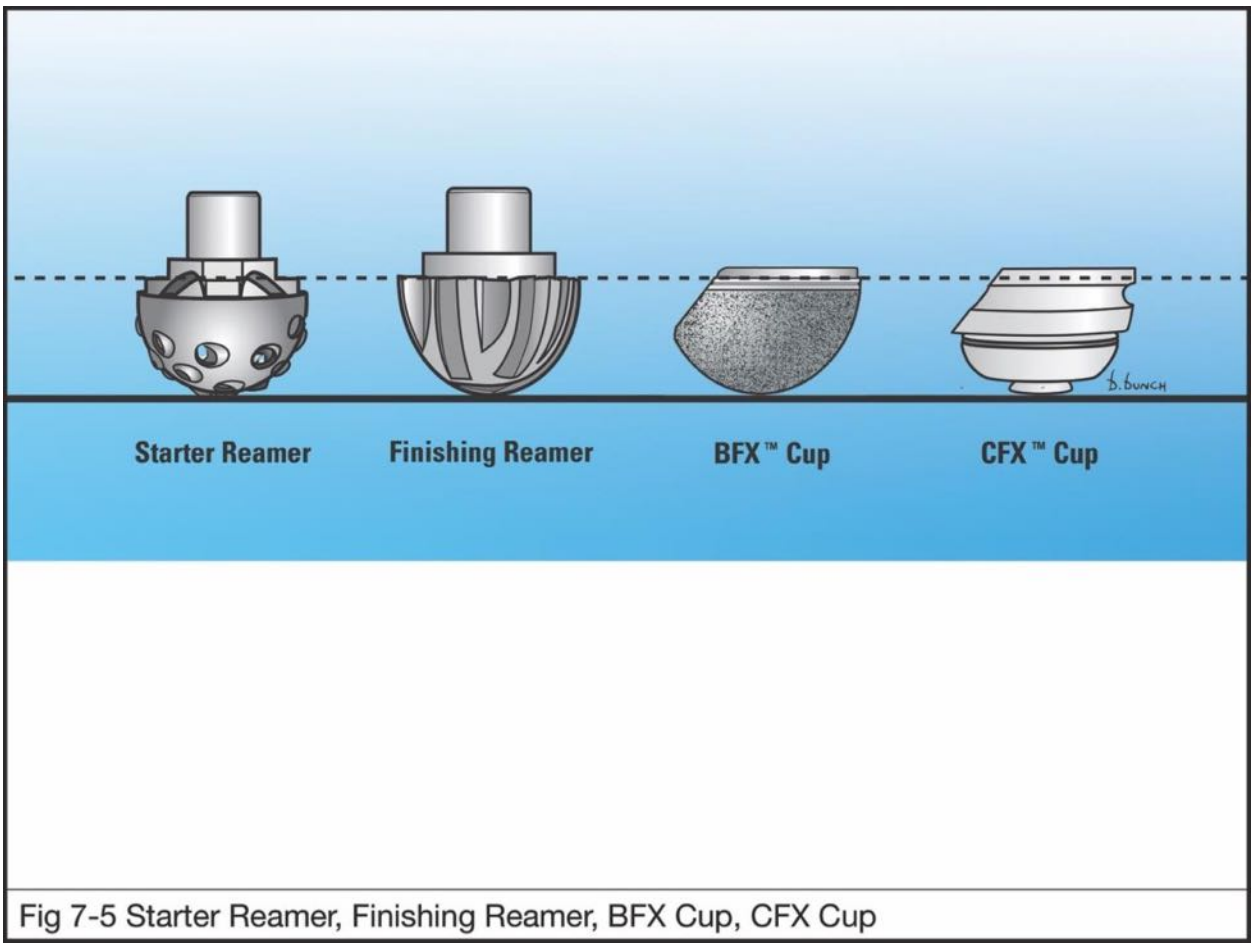


Fig 7-5 Starter Reamer, Finishing Reamer, BFX Cup, CFX Cup

Again, reaming is initiated with the Reamer Shaft held at 15-20 degrees ventral to perpendicular, and in approximately 25 degrees of retroversion. Once the initial bed is established, the Reamer Shaft is positioned in the anatomic axis of the acetabulum (Fig 7-2B & C). The BFX cup is a hemisphere to within 3 mm of the rim. Beyond that depth, it becomes a cylinder and sets the axis or orientation of the cup. This necessitates the last 3-4 mm of reaming depth be done at an angle of 45 degrees ventral to perpendicular and in 25 degrees of retroversion. All reaming with the Finishing Reamer should be done in the anatomic axis of the acetabulum. This angle is determined by placing the Positioning Board Alignment Guide on the two dorsal columns of the Pelvic Positioning Device and holding the Reamer Shaft parallel to the guide (Fig 7-6). The surgeon must ensure that the assistant is holding the base of the guide flat on the columns, otherwise, the angle will be incorrect. Alternatively, the Acetabular Alignment Guide is attached to the Reamer Sleeve and the horizontal Retroversion Alignment Rod is inserted into the appropriate hole labeled “right” or “left” (Fig 7-7). When correctly oriented, these guides will align the reamer 45 degrees ventral to perpendicular and in the appropriate degree of retroversion.

Fig 7-6 Reaming with Positioning Board Alignment Guide

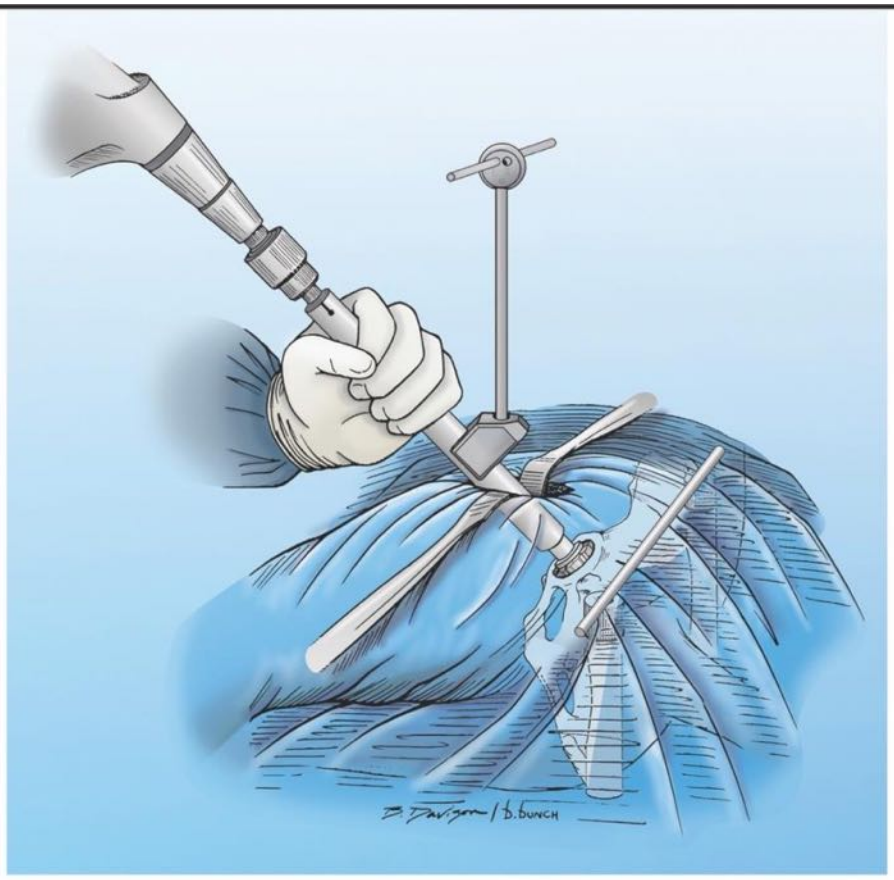


Fig 7-7 Reaming with Acetabular Alignment Guide

The BFX cup is metal-backed. Therefore, it is not as imperative that its entire dorsal aspect is covered by bone as it is with a cemented polyethylene cup. The perceived advantage of dorsal coverage must be weighed against the pitfalls of a deep, or medialized, cup. To place a cup deeper to provide better dorsal coverage, the surgeon can carefully penetrate the medial wall with the reamer. The size of the opening must remain small to prevent the cup from falling through. The periosteum should be left intact to promote bone ingrowth. This step is not recommended except in particular situations, i.e., small pelvis, poor acetabular development, or extreme dorsal rim loss. Reaming through the medial wall must be done with caution, and once done, precludes the use of bone cement.

A Trial Acetabular Cup, when properly aligned using the cup impactor handle and an alignment guide, can provide you with an essential visual reference for ideal cup orientation. It can also help identify the location of any ventral osteophytes or soft tissues that may require removal. Large ventral osteophytes are removed, so they do not push the cup dorsally during insertion. Note: The Trial Acetabular Cups are undersized relative to the corresponding Finishing Reamer. Therefore, the Trial Cups cannot be used to reference the depth of the reamed bone bed

accurately. The depth of the reamed bone bed is referenced off the profile of the Finishing Reamer, with the reamer shaft correctly positioned using the alignment guide.

Once the acetabular bone bed has been prepared, the acetabulum is irrigated, and any remnants of the ligament of the head of the femur, redundant joint capsule, and osteophytes are removed with the aid of a scalpel blade or rongeur before placement of the cup. With BFX implants, it is not necessary to stop all hemorrhage from the bone bed, as it is with a cemented application. The blood is the first step toward fibrous tissue ingrowth and eventual bone ingrowth.

https://www.youtube.com/watch?v=SlixduLwtnw&list=TLGGM1ykeojpR5IwODA4MjAyMg

Module 8 Reading: Acetabular Cup Insertion

BFX Cup Insertion

The appropriate size Central Cup Impactor head is attached to the Cup Impactor Handle. There are several Cup Impactor heads, each covering a different range of cup sizes. The cup is fitted onto the appropriate head in the proper orientation. When handling the cup, avoid touching the porous surface to minimize the risk of contamination. The cup is started into the prepared bone bed parallel to the axis in which the reaming was carried out (Fig 8-1). The angle of cup insertion must be the same as the angle of the final reaming, or the cup will hang up and not seat properly or achieve a press-fit (Fig 8-2). The correct angle is determined by aligning the Impactor Handle with the Positioning Board Alignment Guide sitting on the two dorsal columns of the Pelvic Positioning Device, or with the Acetabular Alignment Guide attached to the Impactor Handle (Fig 8-3). It is important to initially place the cup into the prepared bone bed with a dorsal off-set or slightly ventral, taking care to retract the ventral tissues (Fig-8-4). If tissue is pulled into the bone bed ventrally as the cup is seated, it may prevent seating and press-fit of the cup.

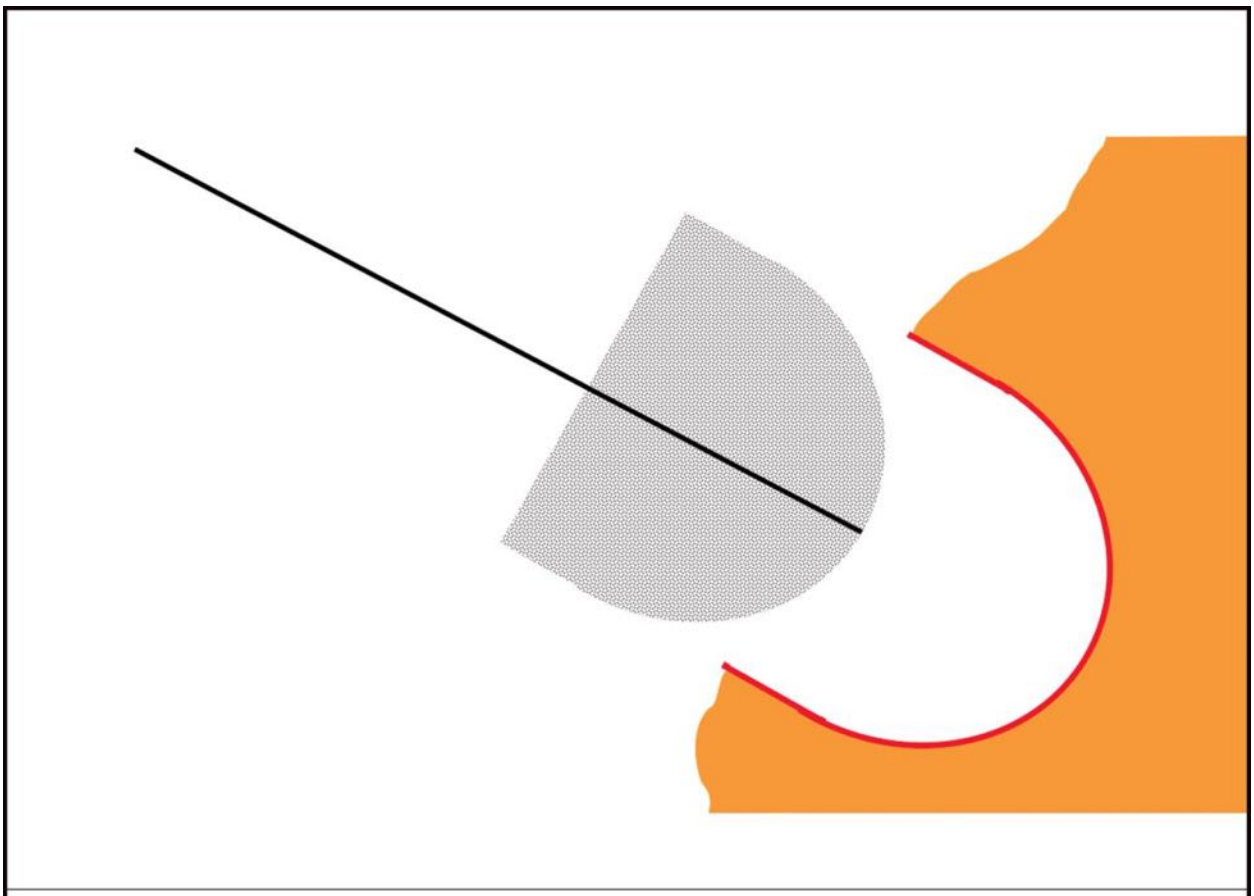


Fig 8-1 Cup Impaction Parallel to Reamed Axis

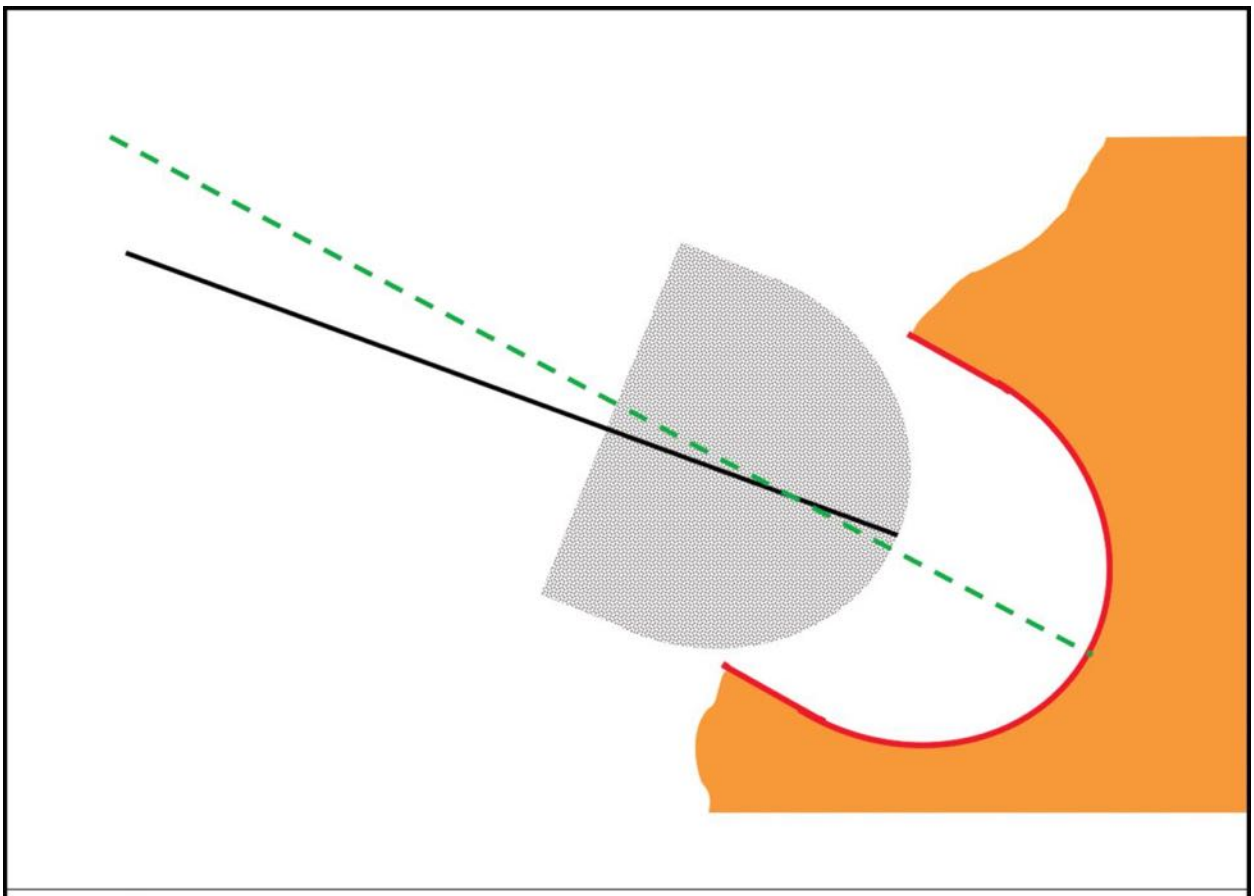
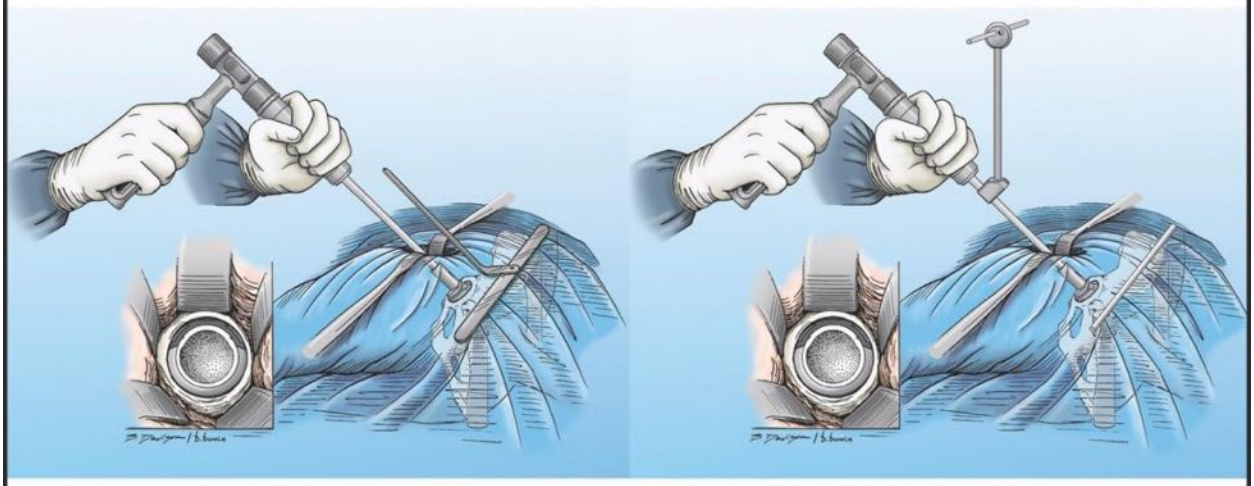


Fig 8-2 Cup Hangs-up Impaction not Axially Aligned



Cup Impaction with Positioning Board Alignment Guide

Cup Impaction with Acetabular Alignment Guide

Fig 8-3 Cup Impaction Guides

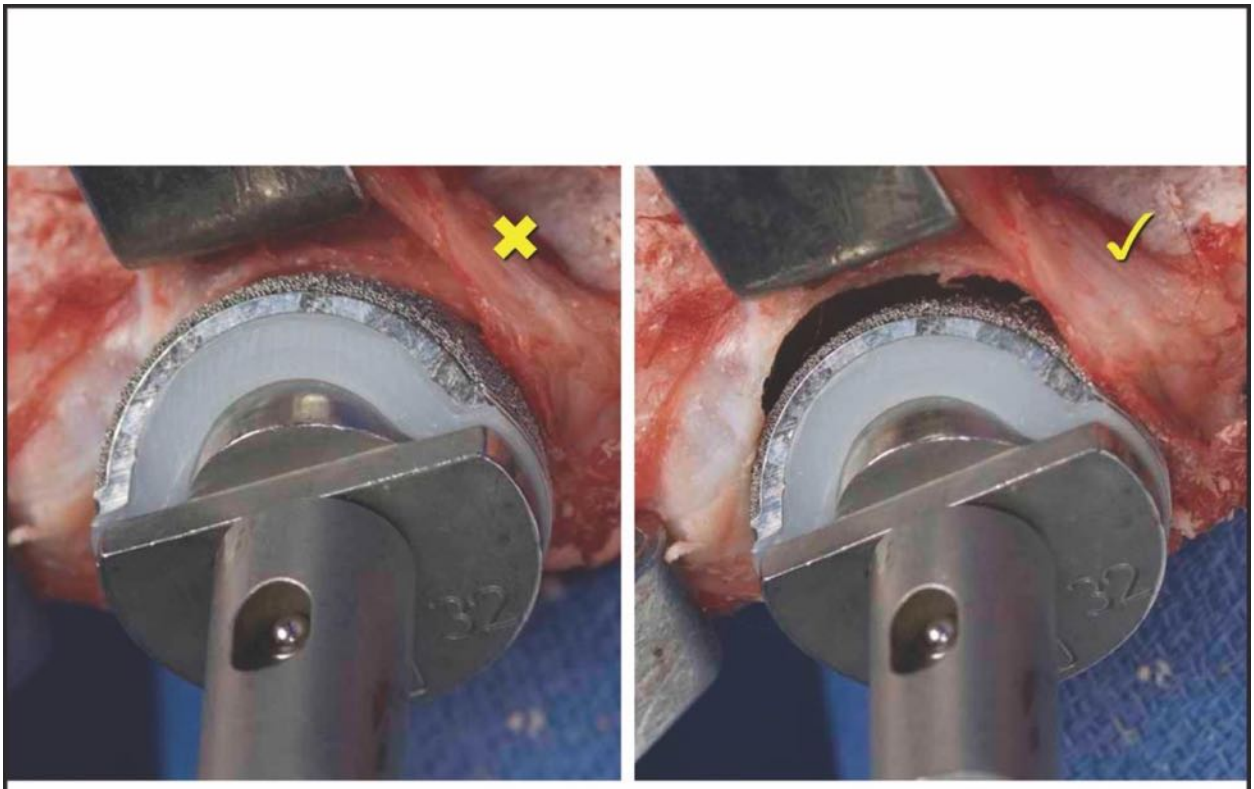


Fig 8-4 Initial Cup Placement: Slightly Ventral

In addition to the angle of lateral opening and the angle of retroversion that are set using the alignment guides, there is a third angle that comes into play during cup impaction that was not a concern during acetabular reaming. That is the angle of inclination. The angle of inclination of the cup is determined by the orientation or rotation of the cup around its anatomic axis. The cup inclination is altered by rotating the Impactor handle. When rotating the impactor handle, care must be taken to ensure that the cup rotates along with the impactor head, since they are not firmly attached. If the cup rotates on the impactor head the truncated portion of the cup will be improperly aligned.

So, in addition to aligning the impactor handle for the angle of lateral opening and the angle of retroversion, you must pay attention to the rotation of the cup. When a cup is fully seated, the truncated portion of the cup should match or align with what would be the "normal" dorsal rim of the acetabulum. Therefore, during insertion, the cup must be rotated so that the cranial and caudal poles of the cup align with the cranial and caudal bone columns of the ilium and ischium (Fig 8-5).

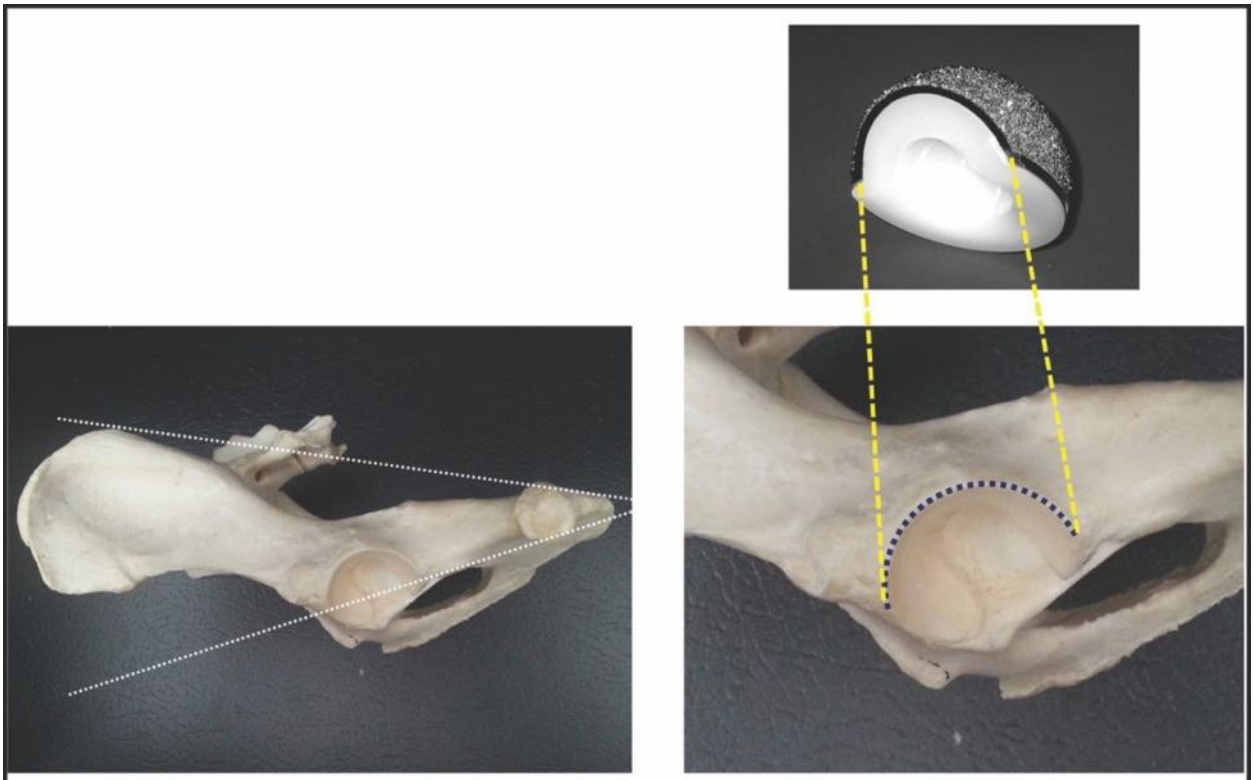


Fig 8-5 Cup Inclination

You can adjust the angle of lateral opening and the angle of retroversion with the off-set impactor head, but you cannot rotate the cup into the correct angle of inclination once partially seated. Seating a cup in an inappropriate angle of inclination may increase the risk of a postoperative luxation. Therefore, it is crucial to assess the inclination or rotation of the cup during and following the initial impaction. If it is not correct, the cup should be removed and reinserted in a different orientation such that the right and left edges of the truncation of the cup match the cranial and caudal poles of the acetabulum before any further impaction occurs. Before impaction is the only time, the angle of inclination can be corrected.

Once alignment is achieved, accounting for all three angles, the cup is impacted only partway. The EBM manufactured porous surface of the cup has a very high coefficient of friction. This friction creates a tight interlock between the cup and the reamed bone bed very early in the impaction process. Therefore, the ability to swivel the cup and reorient it is only possible when the cup is partially seated. Therefore, it is crucial to stop and assess the cup alignment at the very beginning of the impaction, well before the final seating. The angle of lateral opening and the angle of retroversion may be altered using the Offset Cup Impactor. Again, any misalignment in cup rotation requires that the cup be removed and reoriented. After adjustments are made, and you are satisfied that the alignment is correct, the cup is seated the remaining distance using

the Central Cup Impactor by briskly impacting with the Mallet until fully seated. Attention to the sound resonating from the Impactor Handle may give you an indication when the cup is seated, i.e., a higher pitch tone is associated with firm or complete seating.

It is helpful if the assistant positioned dorsally views the alignment of the Impactor Handle during impaction to ensure that the correct angle is maintained. Also, it is important to observe the cup during impaction to make sure it does not shift on the Cup Impactor. Following final seating, the alignment of the cup is verified using the Impactor Handle, Central Cup Impactor, and the Acetabular Alignment Guide. If the cup position needs to be changed, it will be challenging at this point. The Offset Cup Impactor can be used to attempt small changes in cup orientation. If the cup is grossly misaligned and its orientation cannot be altered, it may be best to drive the cup from its bed and reposition it correctly. Choosing to remove and reposition a misaligned cup early in the impaction process will ease removal and will lessen the risk of cup or bone bed damage. The cup can be removed by impacting the metal shell dorsally at the 12 o'clock position or midway on the truncated portion of the cup (Fig 8-6). Initially, the Offset Impactor Head is used to drive the cup out of the bone bed ventrally, swiveling like a "bucket handle" around the most cranial and caudal columns of the acetabulum. Once the dorsal aspect of the cup has rotated below the dorsal rim of the acetabulum, it may be necessary to continue driving the cup with just the tip of the Impactor Handle or with the Stem Impactor tip. The cup can be replaced in the same bone bed provided care is taken when removing it.

https://www.youtube.com/watch?v=6sCdtV2dFWA&list=TLGGzNa5WfC_29wwODA4MjAyMg

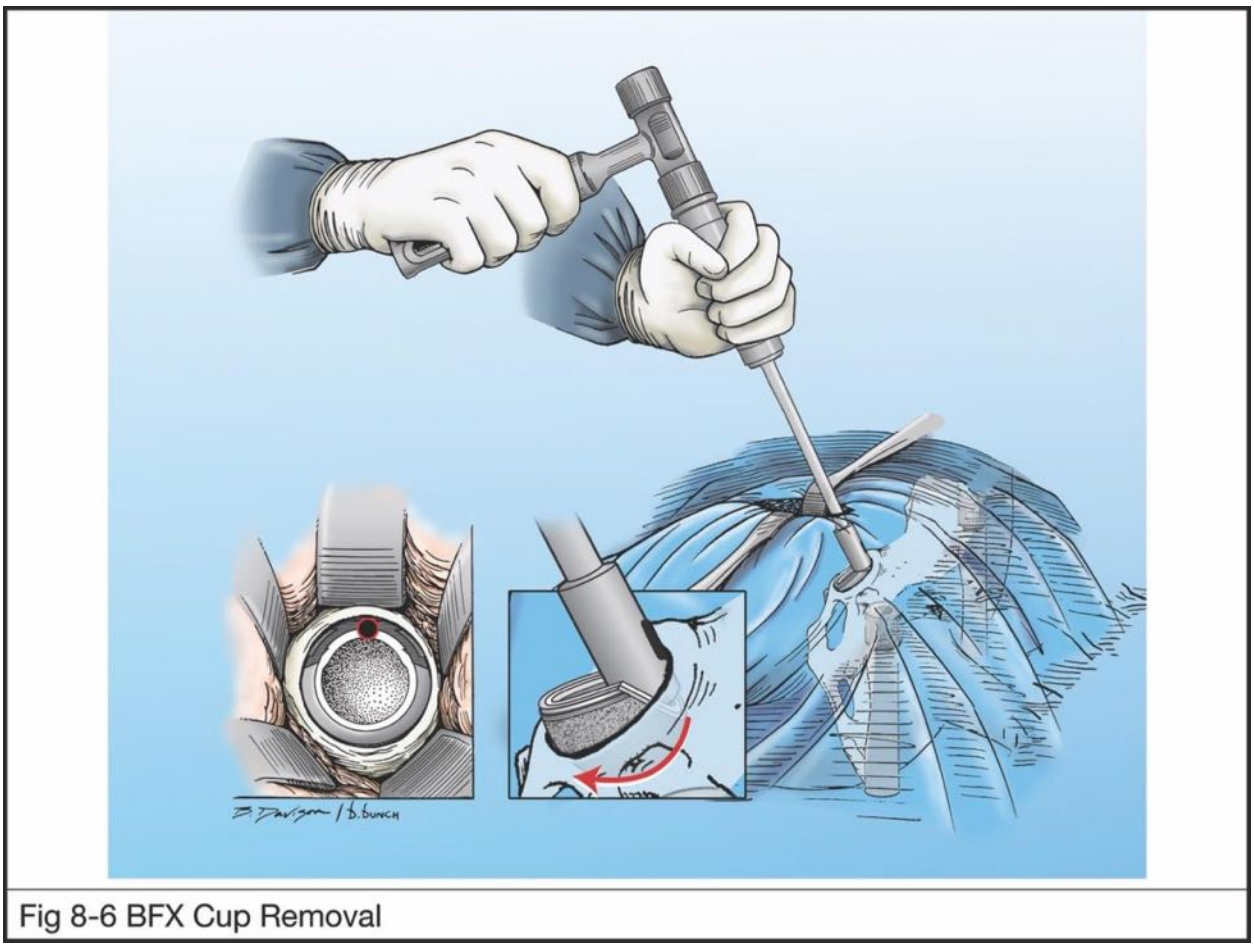


Fig 8-6 BFX Cup Removal

A properly placed cup should be flush with the acetabular bone columns cranially and caudally. Having the cup elevated above the acetabulum caudally (anteversion) may result in a reduced range of motion in external rotation and dislocation caused by neck impingement. The Offset Cup Impactor can be used to impact the cup into retroversion but must be done before final seating. If the cup is not seated flush with the cranial and caudal columns of bone, it may indicate that the cup is not seated deep enough in the acetabulum. In this case, the cup should be removed, and the bone preparation reamed deeper.

CFX Cup Insertion

If a CFX cup is to be placed, 2-3 keyholes are made in the cancellous bone dorsally (Fig 8-7). A narrow trough can also be created dorsally to connect these keyholes using a small curette. The acetabular bone bed is flushed to clean the cancellous bone of debris, and all hemorrhage is stopped. The acetabulum is then filled with bone cement. A CFX cup, which is 1-2 mm smaller than the Finishing Reamer, is selected and mounted onto the Cup Impactor. As with the BFX cup, the CFX cup is fitted onto the Cup Impactor Handle fitted with the Central Cup Impactor head. The cup is inserted into the bone bed using the same alignment instrumentation described for the BFX cup. The CFX cup is seated by hand rather than impacted with the Mallet. Once seated and positioned, all excess bone cement is removed, being careful not to disturb the cup

orientation. Firm pressure is applied to the cup and maintained until the cement hardens. It is critical to remove all particles of bone cement from the joint and adjacent soft tissues as they can act as grit to accelerate wear of the polyethylene cup. Fine wear particles of polyethylene have the potential to result in aseptic loosening of the cup and stem.

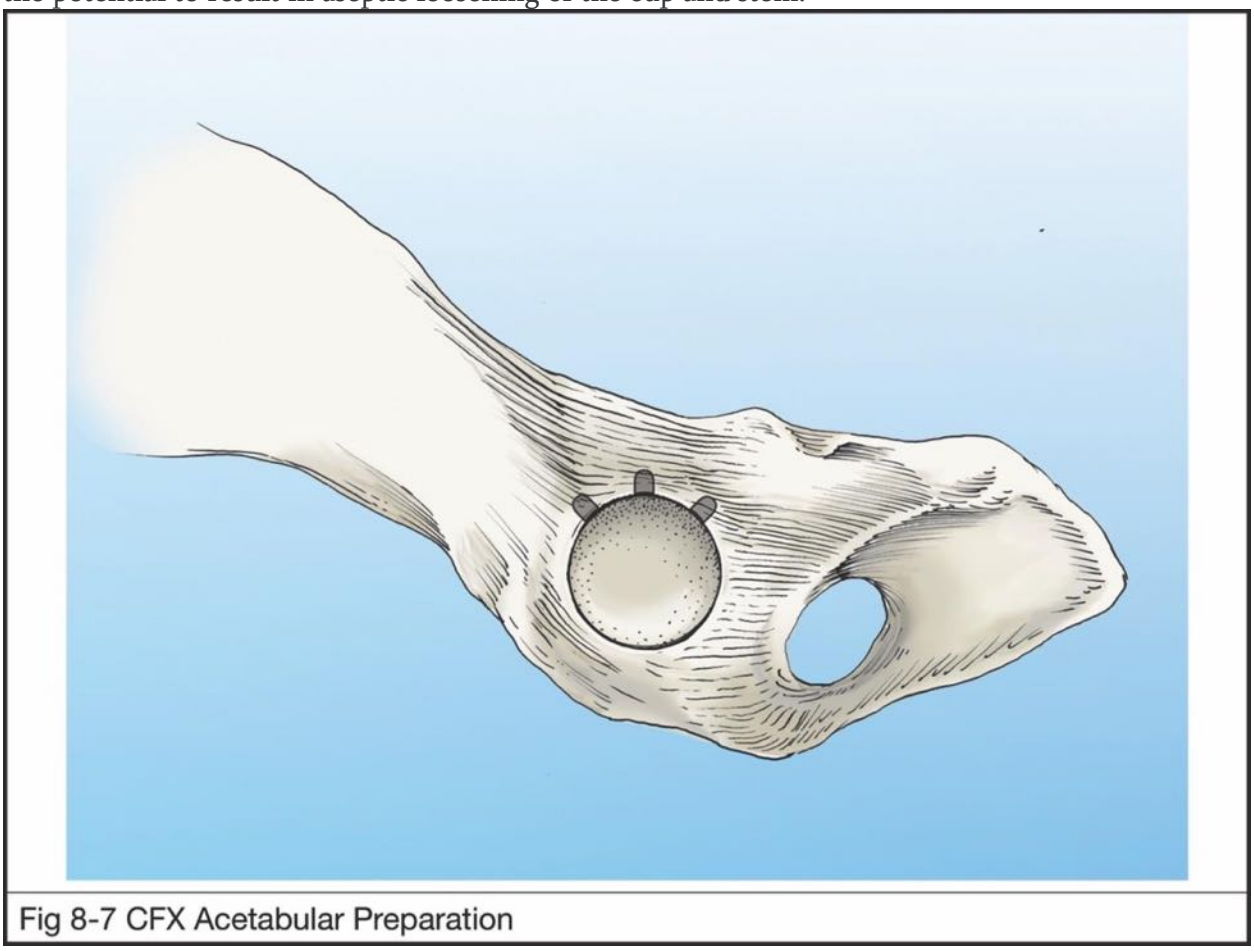


Fig 8-7 CFX Acetabular Preparation

https://www.youtube.com/watch?v=_xQOfvlGF28&list=TLGGN0uWmfGruoowODA4MjAyMg

Module 9 Reading: Femoral Canal Preparation

The limb is rotated 90 degrees, and the proximal end of the femur is elevated from the wound using a large blunt-tipped Hohmann retractor (Fig 9-1). The proximal aspect of the femur must be elevated enough to allow unimpeded passage of the femoral instrumentation down the

anatomic axis of the canal. Femoral canal preparation consists of two basic steps: the initial opening, and the final canal preparation.

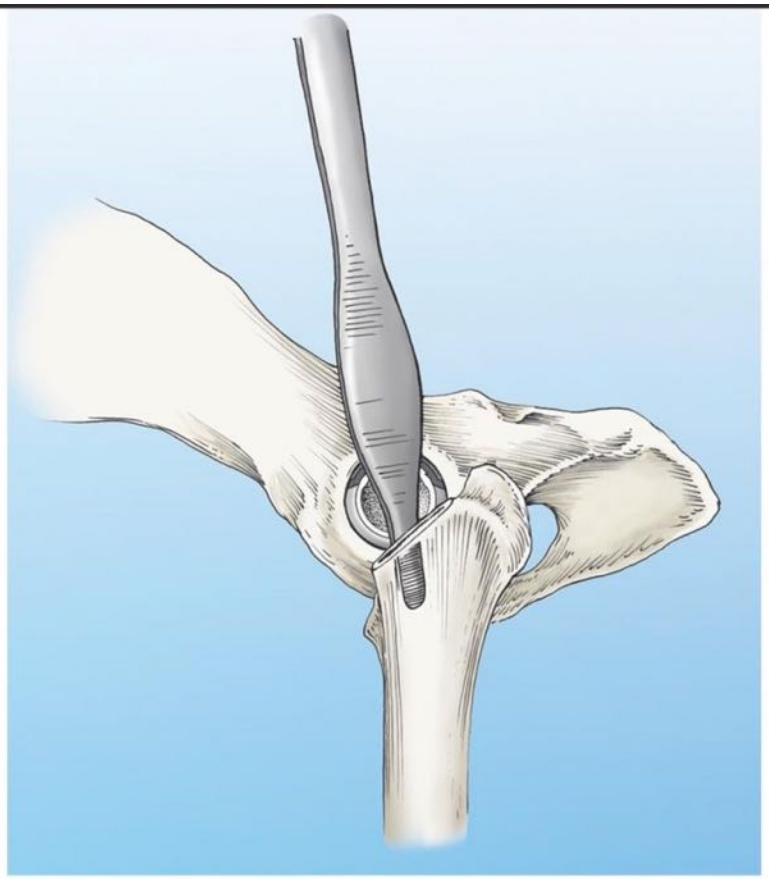


Fig 9-1 Femoral Elevation for Preparation

Initial Opening into Femoral Canal

The initial opening is made into the femoral canal over the anatomic axis of the femur. This point is located medial to the greater trochanter in the trochanteric fossa (Fig 9-2). Proper identification of this point is crucial for canal preparation and positioning of both the BFX and the CFX stems. The point of entry is difficult to visualize due to the presence of soft tissue, and potentially osteophytes in the trochanteric fossa. **Do not enter** the femoral canal through the neck osteotomy site. Accurate placement of the opening is facilitated by creating a pilot hole in the trochanteric fossa with a sharp 3.2 mm (1/8") intramedullary pin. The pin will penetrate soft tissues and osteophytes and engage the sloping surface of the trochanteric fossa. This is the same technique used to place an intramedullary pin or interlocking nail during fracture repair. Once the appropriate point is identified, the pin is driven into the proximal femoral canal parallel with the anatomic axis of the femur. The alignment of the pin must be carefully assessed before entering the femur. Valgus-varus deviation is avoided by directing the pin towards the center of the patella. Cranial-caudal tipping is avoided by ensuring that the pin is aligned with the anatomic axis of the femur as determined during templating on the lateral radiographic view (Fig

9-3A & B). An intraoperative review of the orientation of the anatomic axis relative to the patella helps to obtain the correct alignment. With normal femoral anatomy, the pin is aimed just above the patella (Fig 9-3A). If there is caudal bowing of the femur, the pin will need to be aimed well proximal to the patella (Fig 9-3B). These landmarks apply to the alignment of all femoral preparation instrumentation. Following removal of the 3.2 mm (1/8") pin, a larger 5 mm size drill bit is inserted to expand the opening. Drill bits and reamers are used in conjunction with the Tissue Guard to protect the soft tissues.

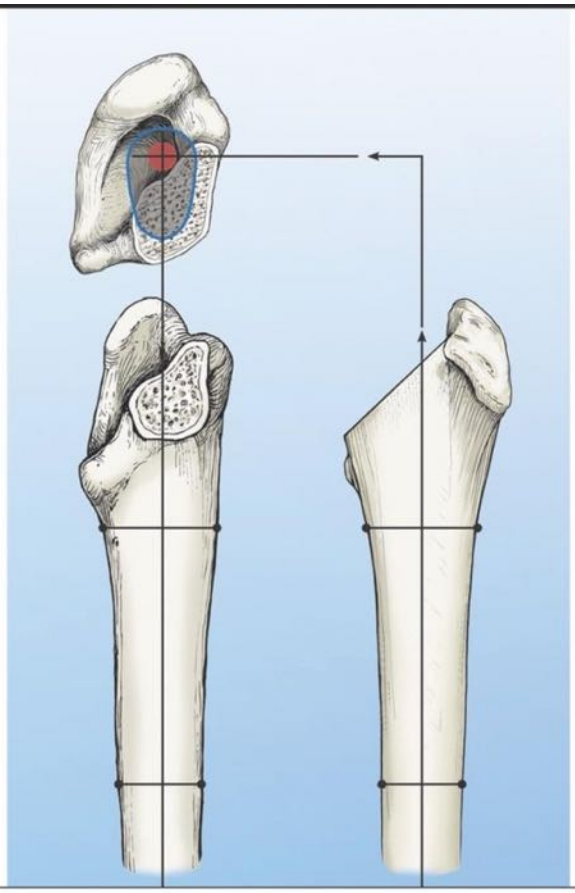


Fig 9-2 Anatomic Axis of Femur - 3 Views

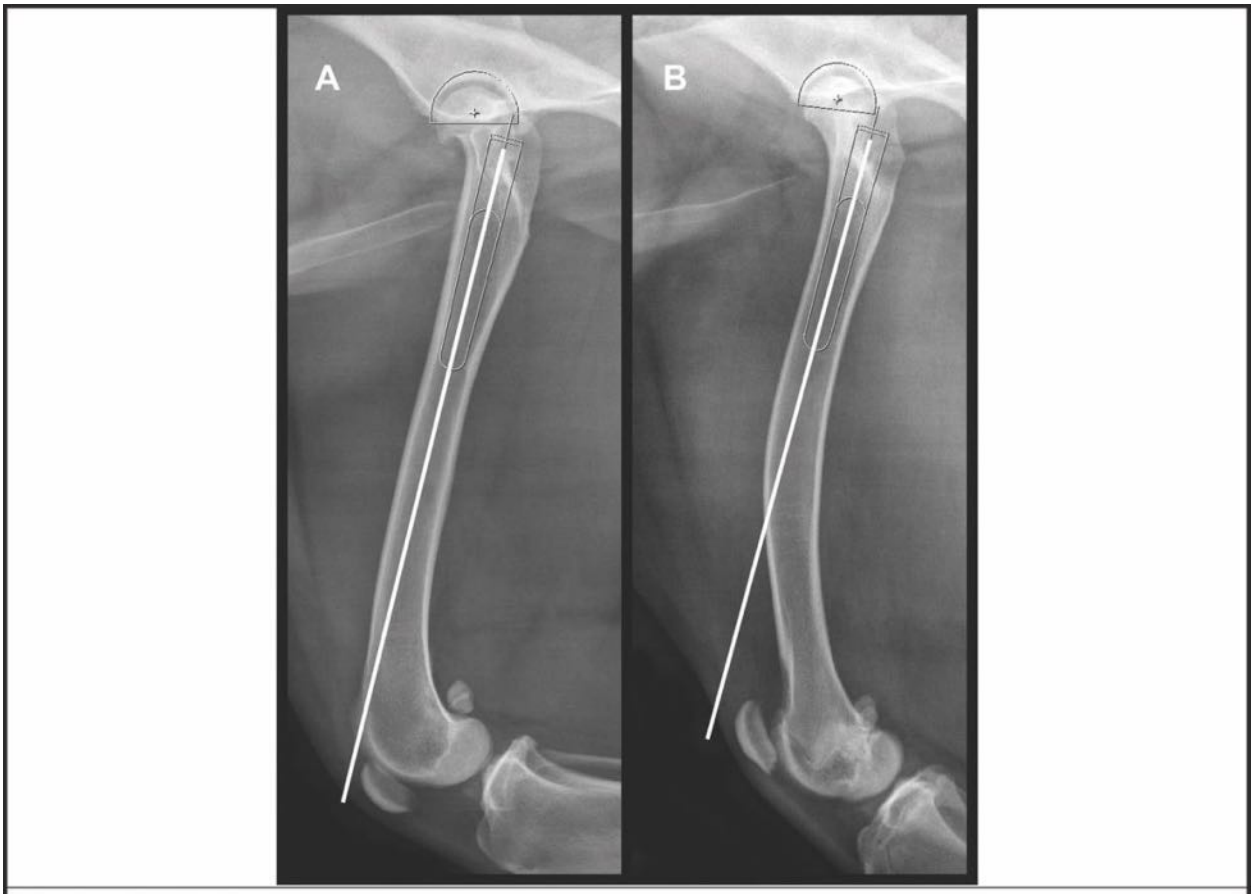


Fig 9-3 A & B Open-Leg Mediolateral Femur Procurvatum

Final Canal Preparation

After the initial opening is made in the trochanteric fossa, the preparation is expanded through the remaining caudal wall of the femoral neck. The hard cortical bone of the caudal femoral neck offers considerable resistance to broaching and makes it difficult to expand the preparation medially into the osteotomy site. Unless the remnant of the femoral neck is removed before broaching, it can inadvertently deflect the broach into retroversion (Fig 9-4). An opening through the caudal femoral neck wall may be created using a rongeur, followed by a side-cutting tapered reamer. Using a rongeur first to remove the caudal neck facilitates the reaming process. The location of this opening or pathway through the caudal neck is essential as it sets the version of the broach. This area is illustrated between the red lines in Fig 9-5 & 9-6. After removal of a portion of the femoral neck, a 4 or 5 mm tapered reamer is power-driven axially into the opening (Fig 9-6). The reamer is positioned axially and held firmly against the neck wall as it is inserted. After partial insertion, the reamer is migrated through the caudal neck wall into the osteotomy site at the point previously identified. Care must be taken not to violate the envelope of the stem shape (blue oval) and only remove enough bone to facilitate initiation of the broaching process. The reamer is never inserted beyond the notch on the fins of the reamer. The final preparation is done using sequentially sized broaches driven by hand with the Mallet. The handle of the broach is held parallel to the anatomic axis of the femur as viewed from two planes (Fig 9-7).

To avoid placing the stem in excessive anteversion or retroversion, the cranial surface of the broach is aligned parallel with the cranial cortex of the femoral neck as it is impacted. "See illustration of the two parallel dotted lines in Fig 9-6". This technique will place the stem in a near-neutral position or similar to the degree of anteversion of the dog's original femoral neck. The stem should be placed neutral or in slight anteversion. Never place a stem in retroversion.

Simultaneously, attention must be taken to ensure proper axial alignment of the broach as it is impacted. You must continuously monitor and adjust the instrument alignment during the impaction process, do not wait until the instrument is grossly misaligned. If the broach becomes misaligned in varus or the tip is directed caudally, it should not be forcibly redirected or straightened in the canal. The broach should be retracted until it can be correctly aligned, and the impaction process resumed with the shaft of the broach held parallel to the anatomic axis of the femur. The surgeon must resist letting the broach slide back into misalignment during reinsertion. Holding the broach using a golfer's grip, with the thumb extended on the shaft rather than like a fist, helps stabilize the shaft axially (Fig 9-7). If the misalignment is severe, the broach may be partially extracted, and the tip used as a rasp to remove bone medial to the trochanter or caudally until the broach can be aligned axially. Once aligned, advance the broach with the Mallet until the proximal-lateral "shoulder" of the broach is seated 2-3 mm below the junction of the femoral neck with the greater trochanter. In surgery, this anatomic reference point is palpable as a bony ridge at the level of the origin of the vastus lateralis muscle on the cranial surface of the femur. This is the reference point for seating the broach in the canal. The slotted slap hammer handle is used to extract the broach in the same Axis in which it was inserted. The next larger size broach is inserted and impacted to the appropriate level (Fig 9-8).

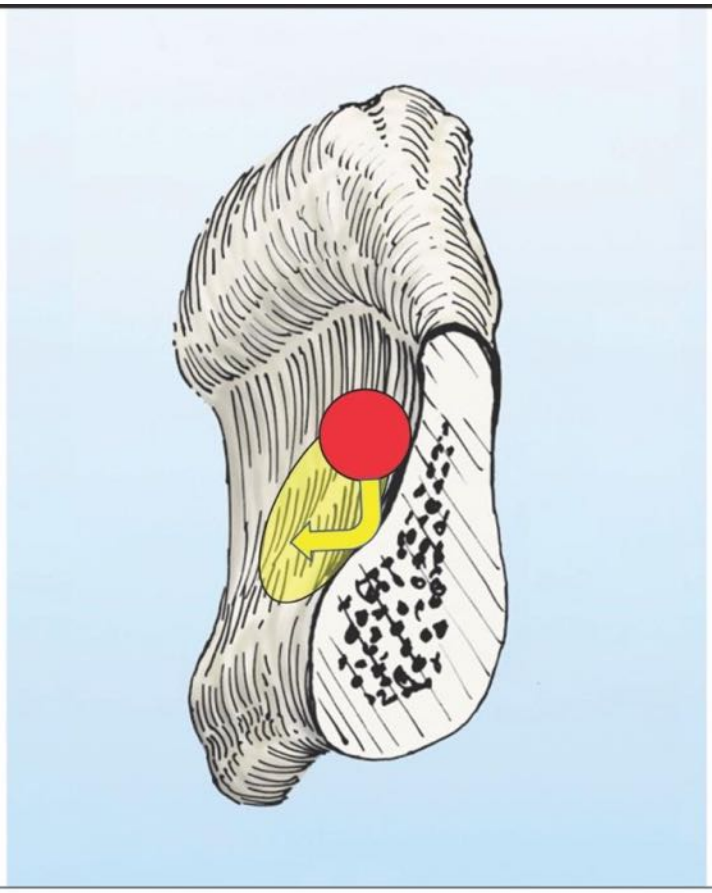


Fig 9-4 Broach Deflection

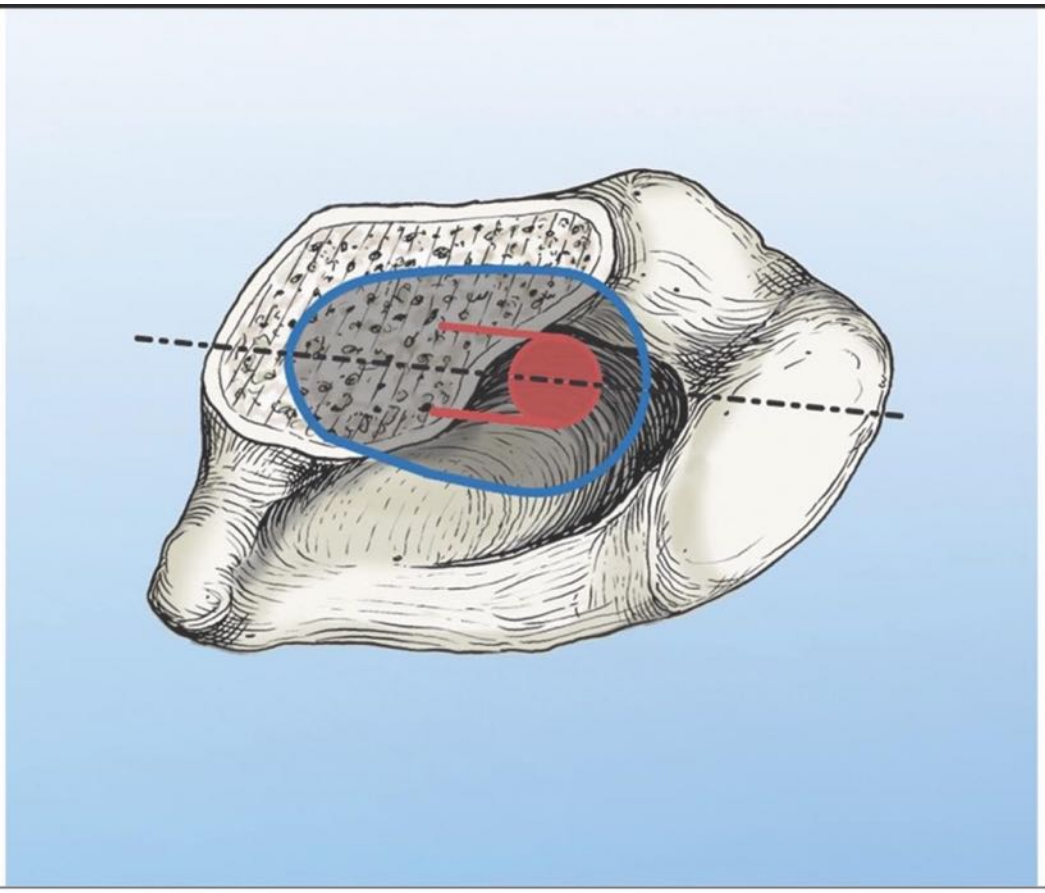


Fig 9-5 Anatomic Axis Femoral Fossa

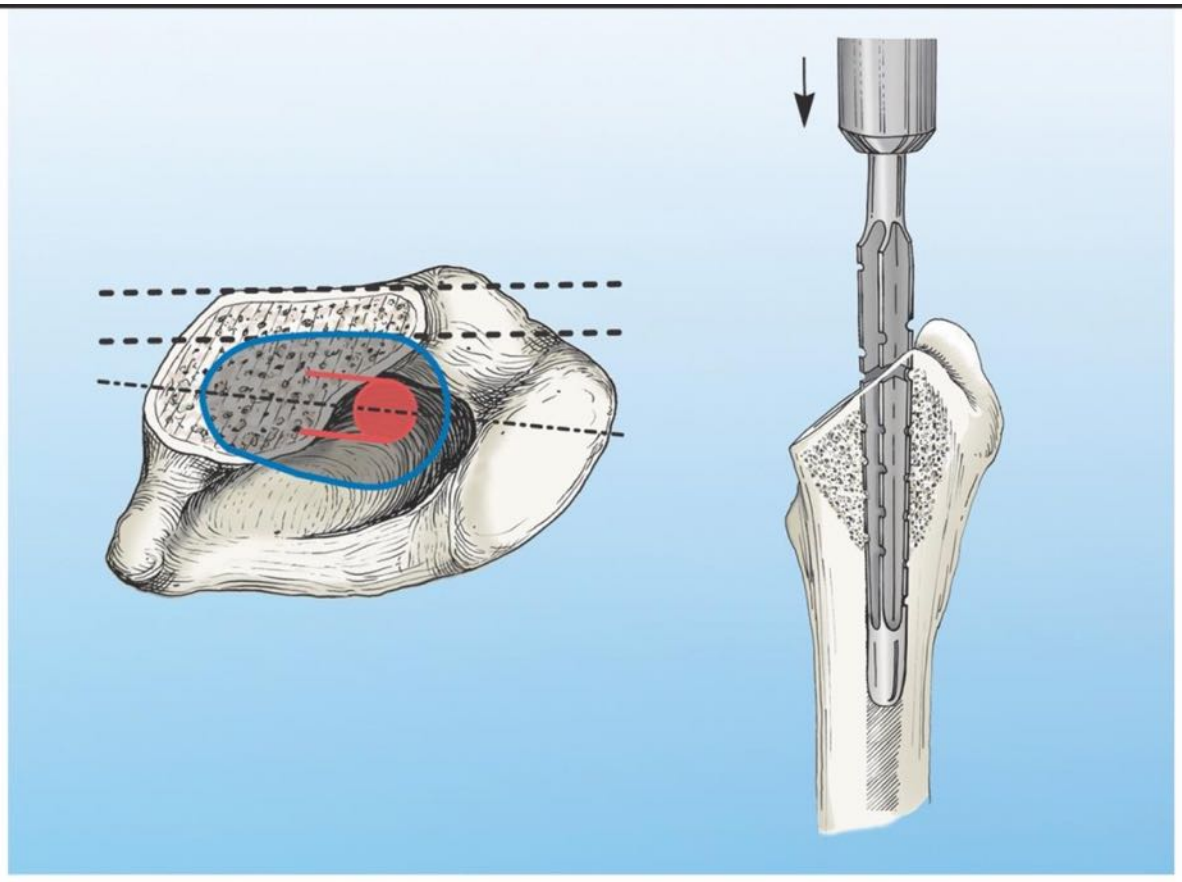


Fig 9-6 Anatomic Femoral Axis with Reamer

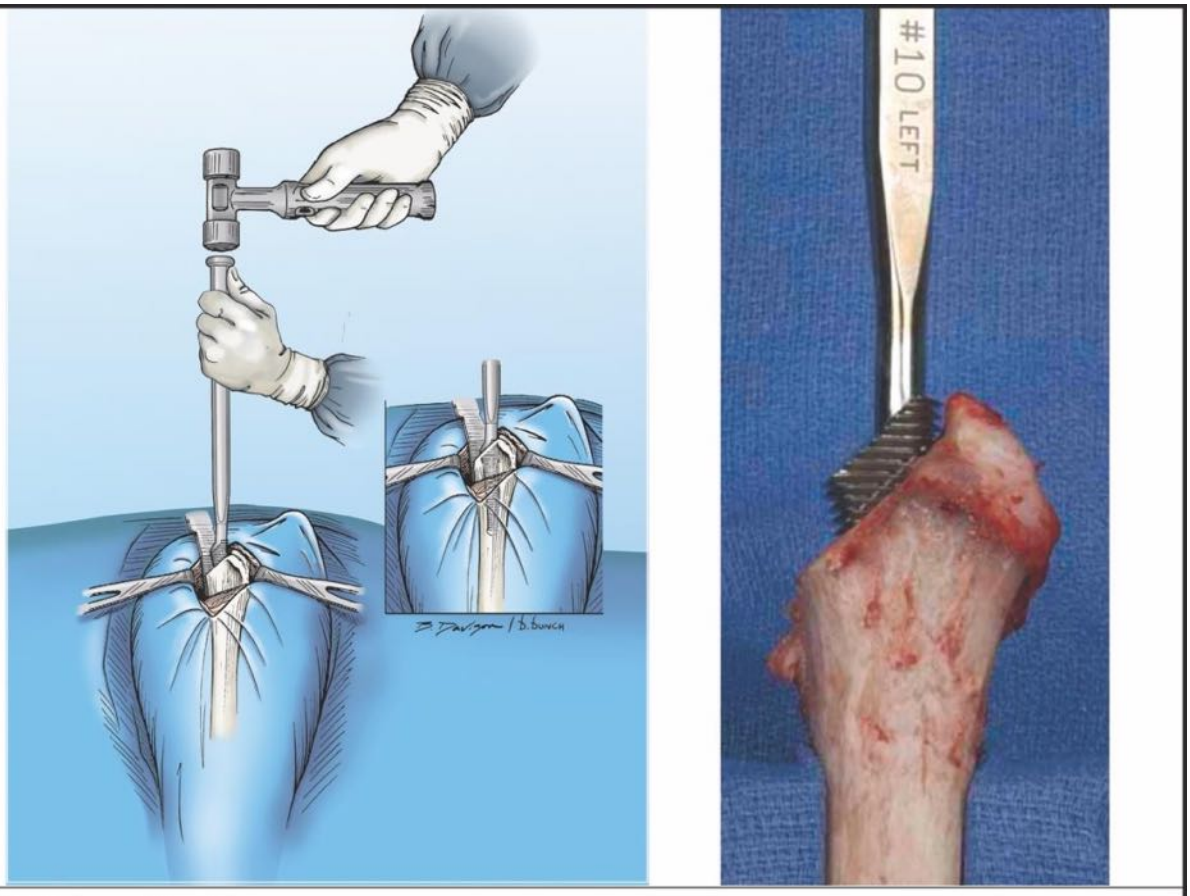


Fig 9-7 Broaching Femur

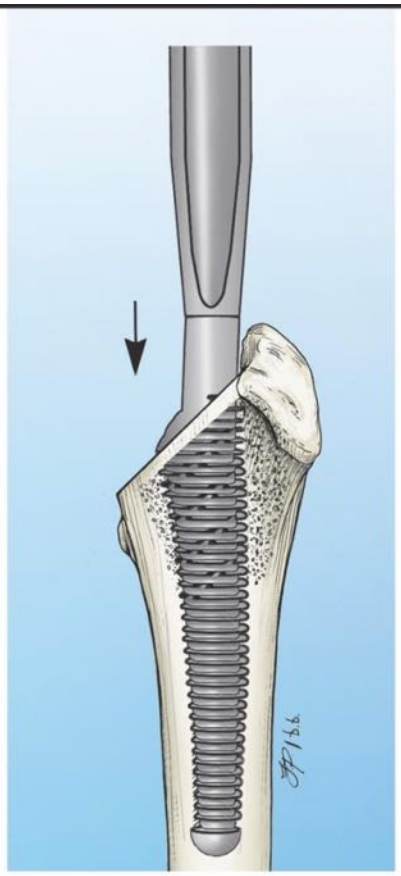


Fig 9-8 Broach Seated

Femoral preparation is continued with sequentially larger broaches until press-fit stability is achieved. Like the acetabular reamer, the broach serves as the trial component. When the appropriate size broach is seated, it should offer "considerable" resistance to further advancement. The final size selection is influenced by preoperative radiographic templating but is determined intraoperatively by the change in resistance during sequential broaching. For that reason, sequential broaching is recommended, so you learn to "feel" the sequential change in resistance to subsidence of the broach as the canal is prepared. Generally, provided the broach is aligned correctly in both planes, the last 5 mm of seating the broach should be significantly more difficult than the previous advancement. Also, the surgeon should note the amount of cancellous bone between the teeth of the broach and the medial and cranial cortical walls when the broach is seated. If there is 4 mm or more of cancellous bone cranial and medial, the next size broach may be indicated. However, a margin of cancellous bone should be preserved between the implant and the cortex, especially cranial and medial. This is true for both the BFX and CFX stems.

When deciding to increase the size of the stem, the surgeon must always keep in mind the largest stem tip that will fit in the femoral diaphysis as determined during preoperative templating. In

“champagne fluted” femoral canals, the diaphysis may be the size limiting point, not the metaphysis. If the surgeon is not comfortable impacting a broach the remaining distance, because it does not advance with “reasonable” impaction force, the broach should be removed and not forced further into the canal. When this happens, switch to the technique of inserting, impacting, removing, and cleaning the broach multiple times until seated. Alternately, a smaller broach can be reinserted into the femoral canal and used as a rasp to selectively remove bone medial to the greater trochanter and caudally. Extreme caution must be exercised not to rasp away too much bone when this technique is used for seating the final size broach. If it is overdone, you risk the loss of press-fit by enlarging the preparation beyond the tolerance for press-fit. The broach must be custom fit slowly; one or two strokes or rasping motions with the broach may be sufficient. Never use the finishing file for this procedure.

Forces resulting from impaction of the broach are uniformly distributed outward and are unlikely to result in a fissure fracture provided the broach is aligned parallel with the anatomic axis of the femur and enters the canal over the anatomic axis. Situations predisposing to femoral fracture include starting the femoral broach into the canal from the femoral neck osteotomy site, varus or caudal alignment of the broach, excessive bending or rotation of the broach in the femur or attempting to fill the bone with too large an implant. You should not try to fill the canal, endosteum to endosteum, as there is a risk in trying to do this, and it’s usually not necessary as press-fit conditions can be met with a smaller implant. Fractures can also result from, inadequate elevation of the proximal aspect of the femur, or the femur slipping off the retractor used for elevation. The resulting bending force can cause a fracture. Twisting the broacharound its long axis or placing the broach in excessive anteversion can wedge the cortical walls apart, resulting in a fracture, as can lifting on the broach. It is recommended that the Mallet with the slap hammer handle be used to impact the broach. The old saying “if it doesn’t fit, get a bigger hammer” does not apply when impacting a femoral broach or stem. Fissure fractures are technique related and most often result from varus or caudal alignment of the broach. Attention to proper elevation of the proximal aspect of the femur, and appropriate use and alignment of the broaches combined with selective rasping reduce or eliminate the incidence of fissure fractures. Also, during femoral canal preparation, an assistant must provide resistance on the stifle joint to counteract the impact of the Mallet on the broach to minimize the chance of the proximal aspect of the femur slipping off the retractor.

The cranial-medial region of the femoral neck should be closely observed during broaching and stem insertion for the development of a fissure. If a fissure does happen, canal preparation or stem insertion should be stopped, and the broach or stem removed. It is recommended to place 2-3 double loop cerclage spaced 1-2 cm apart with at least one placed distal to the visible extent of the fissure in all cases. Broaching or stem insertion is then resumed. If the broaching process or stem implantation cannot proceed without the fissure widening despite the cerclage application, conversion to a CFX stem may be necessary. Occasionally a diaphyseal fissure may develop during broaching or impaction of a stem. If broaching has been difficult, it is recommended that you reflect the vastus cranially to inspect this area of the bone before beginning closure. The

implant may obscure fissures in the bone on postoperative radiographs.

In dogs with advanced hip dysplasia, the metaphyseal region of the proximal femur can become calcified or sclerotic. Also, disease of the femoral head and neck or injury to the capital physis may lead to sclerosis of the intramedullary bone. The sclerosis can range from dense cortical-cancellous bone to extremely hard "ivory-like" bone and can extend various depths into the metaphysis. The presence of the sclerotic bone in the metaphysis makes femoral preparation challenging. This condition must be recognized before surgery on the preoperative radiographs (Fig 9-9). If you are aware of the situation ahead of time, you won't be surprised, and you can have the necessary instrumentation available during surgery. The presence of the sclerotic bone may lead one to implant a proximally positioned stem in varus, and a stem that is undersized relative to the femur and bodyweight of the patient. A potential consequence of implanting an undersized stem positioned too proximal in the femur is fatigue fracture of the stem (Fig 9-10A, B & C).

Factors contributing to stem fracture are:

1. An undersized stem for the size of the femur and the bodyweight of the dog.
2. A stem positioned too proximal in the femur, limiting the amount of bone surrounding and supporting the proximal stem.
3. A small stem placed in varus leading to an increase in the moment arm, generating excessive bending stress on the proximal aspect of the stem.

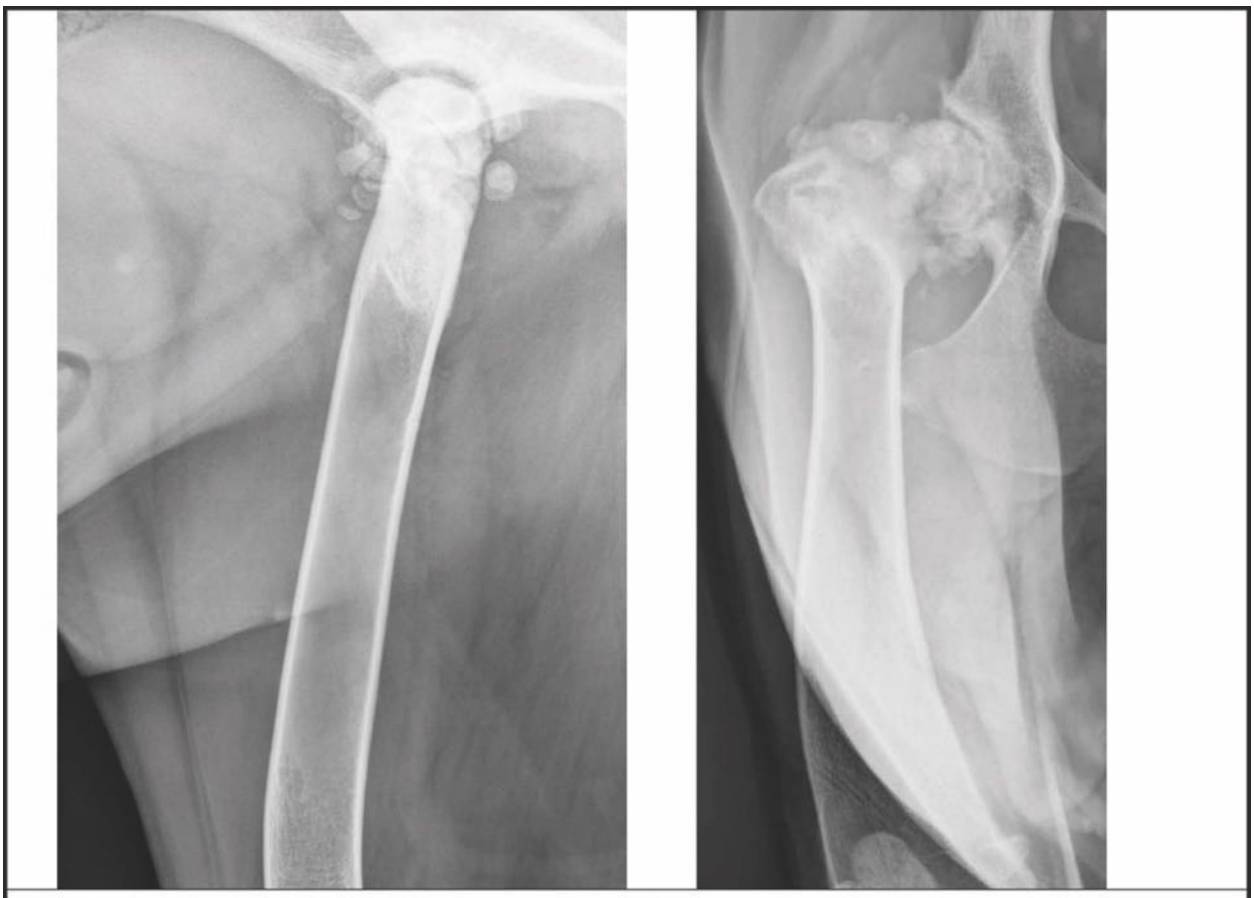


Fig 9-9 Sclerotic Bone in Proximal Femoral Metaphysis

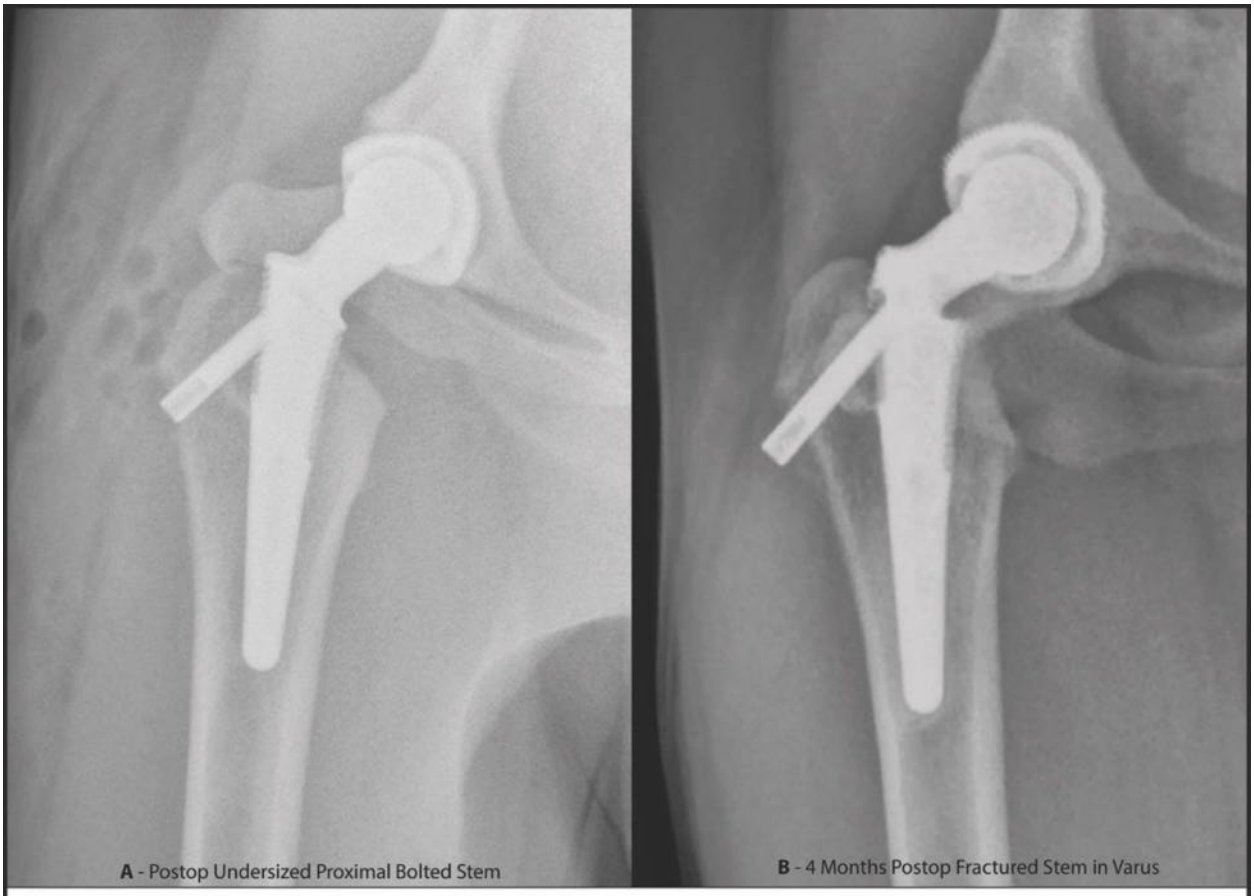


Fig 9-10 A & B Postop Undersized Bolted Stem

Modified Femoral Preparation for Sclerotic Femurs

An opening through the sclerotic bone into the normal medullary canal must be made large enough to allow entry of the broach. Penetration through this hard bone is not possible using the routine technique with an IM pin, drill bit, and fluted reamer. It is impossible to create the opening using an intramedullary pin, but a small drill bit is generally successful in drilling through the hard bone. A pneumatic burr can be used to create a starting point for the drill bit, or in some cases, it can be used to make the opening through the sclerotic bone. However, it is more challenging to maintain axial alignment with a burr than with a drill bit. You must take care to ensure that the opening is parallel with the anatomic axis of the femur, as it is impossible to modify once established. The drill hole is enlarged using sequentially larger drill bits until the cutting teeth of the broach can be inserted. The round drill hole is expanded into an oval using a small curved osteotome or pneumatic burr to facilitate the insertion of the broach. The oval is oriented parallel to the cranial cortex of the femur since it determines the degree of anteversion of the broach. If the oval opening is misoriented, it is difficult to change later. Side cutting reamers may be ineffective in cutting through the sclerotic bone. Use them with caution to avoid fissure or fracture. The broaching process through sclerotic metaphyseal bone is frustrating and

challenging. Millimeters of progress take time and patience. The best approach is to alternate between broach impaction and rasping. Advance the broach until it stops, then remove the broach and clean the teeth of debris. Insert a smaller broach and use it as a rasp to file away bone in the desired directions. Then impact the larger broach again until it stops and repeat the process. Continue until you have reached the final desired size and depth of femoral preparation. The original CFX broaches may perform better in the sclerotic bone than the current generation of Universal Hip Broaches and are available upon request. Because of the low or absent elasticity of the sclerotic bone, slight over-broaching (resulting in a lower drive distance) may be necessary to achieve full implant insertion depth.

Because of the difficulty broaching the sclerotic bone, there is a tendency to undersize the femoral stem 1-2 sizes. Subsidence is less of an issue when seating a stem into hard cortical bone as the bone offers considerable resistance. However, placing too small a stem, may not provide adequate neck length following joint reduction and may be inadequate for the dog's weight. Regardless of the stem size, it is critical that the stem be press-fit into the bone in axial alignment and seated to the proper depth. The porous surface of the stem is implanted in the bone for ingrowth stabilization and to shield the proximal portion of the stem from bending forces. Fully seating the stem is especially crucial if a bolted stem is implanted. An undersized bolted stem not seated to its full depth is exposed to excessive bending forces, and a stem fracture can occur through the bolt hole.

https://www.youtube.com/watch?v=t-pzfsjaGkY&list=TLGGxWIbCPD7Lu8wODA4MjAyMg

Module 10 Reading: Femoral Stem Insertion

BFX Stem insertion

The femur is maintained in the same position as during the broaching procedure. The appropriate BFX femoral component is held by the neck and inserted by hand into the prepared femoral canal, in the same plane, and degree of anteversion as the extracted broach. Care must be taken to ensure that soft tissues are not dragged into the prepared bone bed during implant insertion. When resistance to hand seating is met, the component is seated the remaining "drive" distance with the Stem Impactor and the Mallet (Fig 10-1 & 10-2). After hand seating, a femoral stem, the remaining distance to final seating with a mallet, is referred to as the drive distance. The drive distance is generally measured by the amount of the porous portion of the stem exposed. The proximal-lateral "shoulder" of the femoral stem should be seated to the same level as was achieved with the last broach. Recall that this anatomic reference point is palpable as a

bony ridge at the level of origin of the vastus lateralis muscle. The proximal aspect of this bony ridge is the reference point for seating the femoral stem in the canal. The level of final seating may be anywhere from 2-3 mm above or below this ideal insertion point, based on the degree of resistance to impaction. If the stem was easily advanced beyond the desired seating point, subsidence is likely to happen when the implant is loaded. If this happens, the femoral component should be extracted, and the medullary canal expanded with the next size broach to accommodate a larger implant. However, this is assuming there is room within the femoral canal to accept the next size implant based upon radiographic templating. You should also keep in mind that the underlying issue may be that an adequate press-fit is not achievable due to the poor quality of cancellous bone. Since the augmented stems must also be press-fit, the best decision may be to switch to a CFX stem.

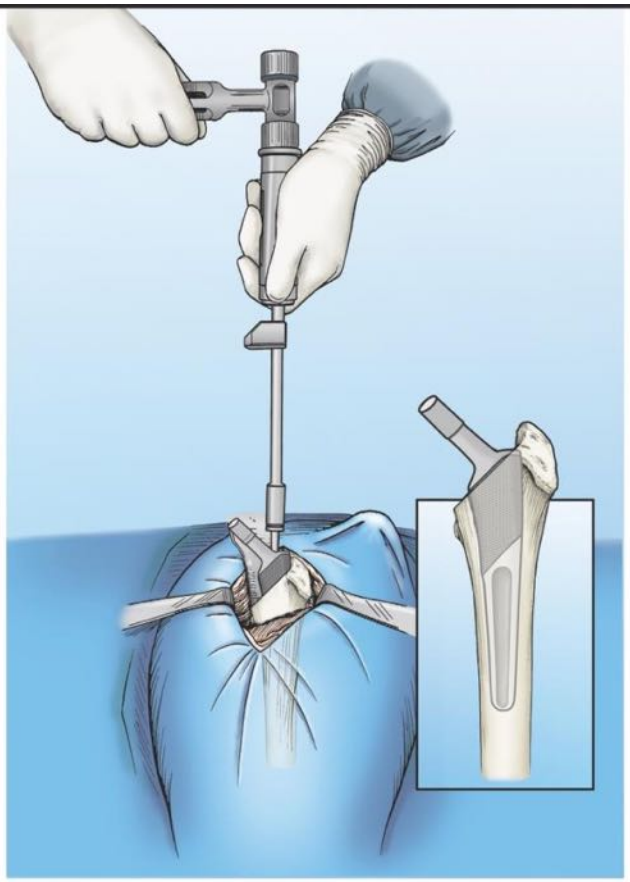


Fig 10-1 Impacting BFX Stem

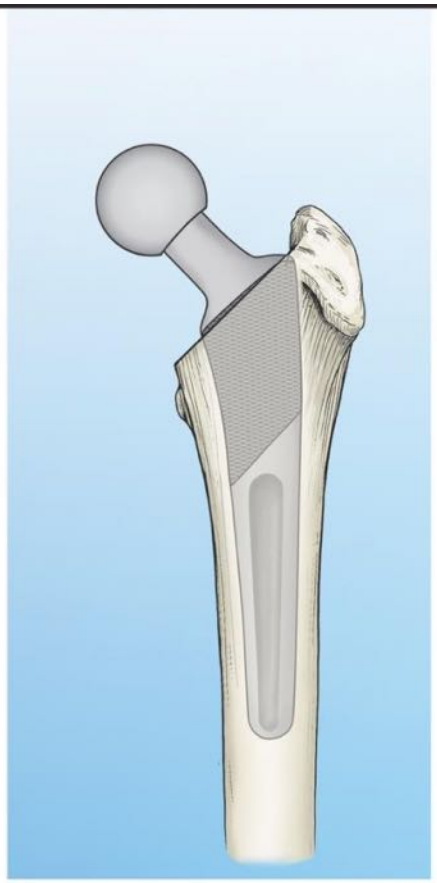


Fig 10-2 Seated BFX Stem

After hand seating the stem, the surgeon must assess the remaining drive distance before impaction with the Mallet. The drive distance should be no more than one-third the length of the porous portion of the stem. If the drive distance is greater than this, the preparation is cautiously expanded using the next larger broach. This must be done in a manner to avoid oversizing the preparation resulting in loss of press-fit. The stem should be removed from the canal, and the next largest size broach hand-inserted until it stops. The broach is advanced approximately two rows of teeth, and the desired stem reinserted. The drive distance is reassessed. This sequence is continued until the stem has a drive distance of approximately one-third of the porous section. If a stem must be extracted during surgery, the Slide Hammer Stem Extractor is attached firmly to the neck of the stem, and the stem is removed by sliding the weight along the instrument shaft away from the implant.

CFX Stem Insertion

If a CFX stem is to be implanted, the femoral canal is prepared as described above. A CFX Trial Stem, 1-2 mm smaller than the broach used for the preparation, is inserted into the prepared bone bed until the collar contacts the cranial and medial cortex. If the collar contacts the cortex of the caudal neck first, preventing the collar from seating on the cranial and medial cortex, a

rasp or rongeur can be used to remove a portion of the caudal neck. Collar contact with the osteotomy site is important for transferring the load from the stem to the bone, and it determines the axial alignment of the stem in the canal. If necessary, the angle of the osteotomy can be altered using the finishing file to improve the axial alignment of the stem. If you are unable to reduce the joint because the neck length is too long, you can go down one stem size with a shorter neck or lower the neck cut to seat the implant lower. Seating the implant lower in the femur essentially shortens the neck length.

Alternatively, if a CFX implant was intended to be used from the beginning, the femur can be prepared using sequential power reamers inserted axially into the original opening in the trochanteric fossa. The final power reamer used is the same size as the intended stem size. With the CFX stem, the reamer can be inserted to the top of the reamer, not just to the notch. The opening can then be finished by impacting a broach one size larger than the CFX stem or hand rasping using a smaller broach as a rasp to remove bone until the stem can be axially aligned.

Always use the trial cup and stem to determine the adequacy of the bone bed preparation, rather than the implant, to ensure the implant remains clean. Fat and marrow cannot be adequately washed off the implant surface with saline during surgery. Studies have shown that the bonding strength of a stem with the cement is decreased by over 80 percent if the stem is wet or contaminated with fat or marrow. This can predispose to debonding at the implant-cement interface. Before cementing the CFX stem, a trial reduction is carefully made to assess the tightness of the reduction. If reduction difficulty happens and a revision of the osteotomy is required to facilitate reduction, it is best to discover this before cementing the final implant.

Once the canal preparation is completed, a polyethylene Cement Plug is inserted into the diaphysis, below the level of the stem tip. The plug restricts cement from flowing down into distal canal and allows pressurization of the cement into the trabeculae of the cancellous bone (Fig 10-3). The size Cement Plug is chosen based on the preoperative templating step. Stem sizes #8 and larger require the Large Cement Plug and stem sizes #7 and smaller use the Small Cement Plug. The canal is dried with suction and injected with bone cement in the low viscosity stage, starting from the Cement Plug out. As the canal is being filled with cement, thumb pressure over the neck resection area can help to pressurize the cement into the previously cleaned and dried cancellous bone. The CFX stem is inserted into the cement-filled canal until the collar of the prosthesis contacts the femoral osteotomy (Fig 10-4). If a centralizer was used on the stem tip, and resistance is encountered during seating, the Mallet is used to tap the Stem Impactor Handle and seat the stem the remaining distance into the canal. The stem is held firmly in place until the cement hardens and any excess cement removed from the tissues surrounding the joint and the acetabular cup. It is recommended that a CFX Stem Centralizer and a Cement Plug be used whenever the bone size allows. The centralizer has flanges that keep the stem tip away from the cortical wall and allows bone cement to remain or flow between the centralizer and the cortical wall.

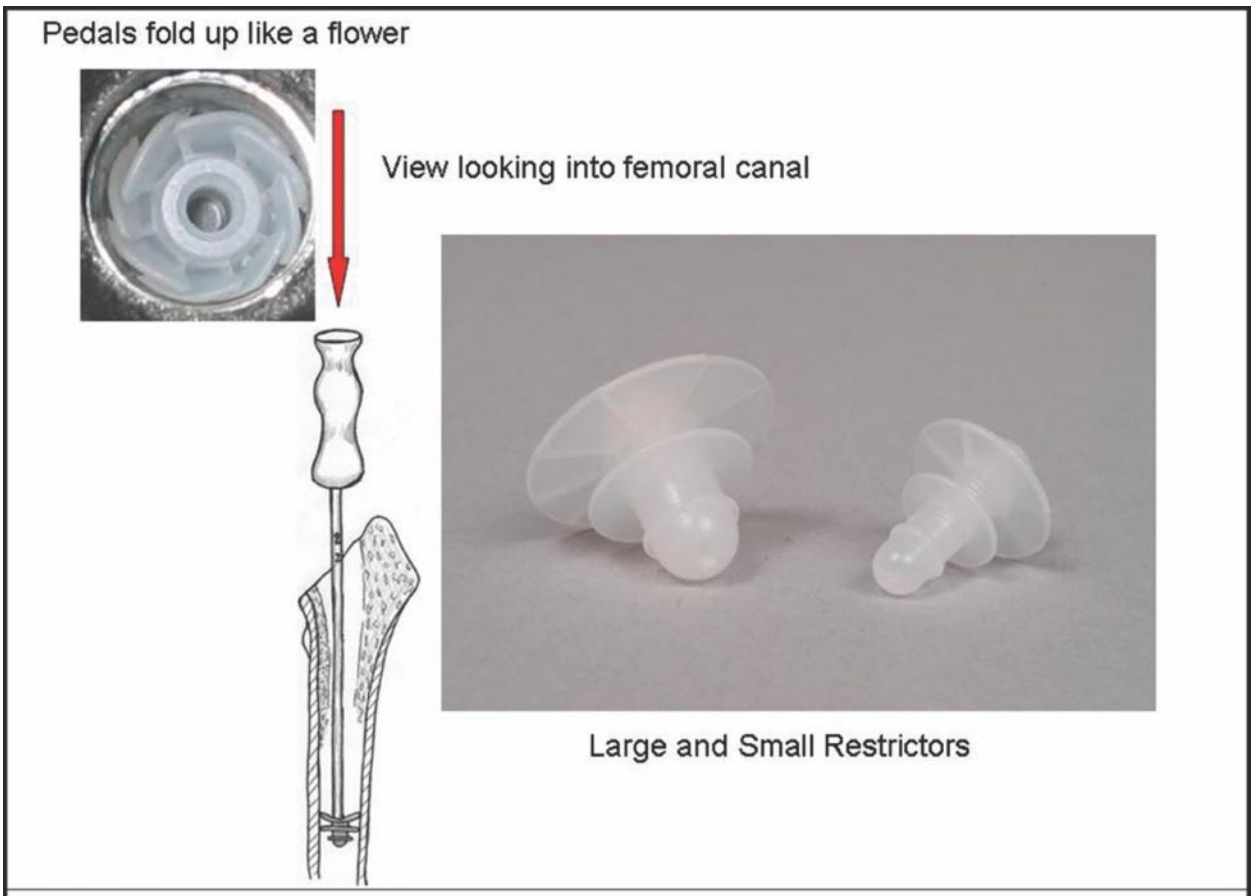


Fig 10-3 Cement plug with Inserter

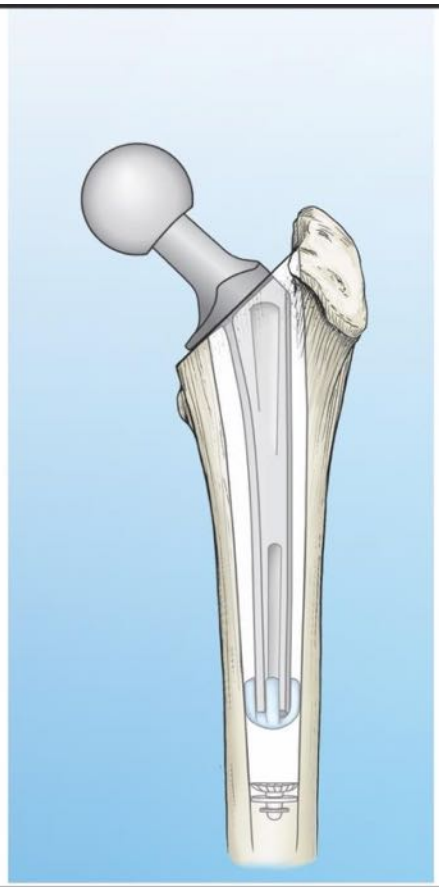


Fig 10-4 Cemented CFX Stem

Always follow the manufacturer's recommendations for mixing the bone cement. It is recommended to fill the canal with cement from distal to proximal regardless of whether a Cement Plug is used or not. If a Cement Plug is not used, care must be taken that the cement is not pumped distally into the femur, leaving insufficient cement to fill the proximal aspect of the canal. Also, it is important to recognize that operating room temperature significantly influences the setting time of the cement. A cooler room temperature slows down the setting time, and a warmer temperature (above 72 degrees F) accelerates it.

In summary, the integrity and survival of a cemented stem are influenced by:

1. The preparation of the bone bed.
2. The amount of cancellous bone remaining proximally.
3. The elimination of hemorrhage.
4. Cleaning and drying the bone bed before injecting the cement.
5. Avoiding contact of stem tip with the cortical wall using a Stem Centralizer.
6. Restricting the cement flow distally using a Cement Plug.
7. Injecting a homogeneous mass of cement that is free of blood.
8. Pressurizing the cement into the cancellous bone.

9. Inserting a clean, dry implant in axial alignment.
10. Holding the implant motionless until the cement has cured.

https://www.youtube.com/watch?v=xbd0Sy7YURU&list=TLGGWOj5f6fo9NAwODA4MjAyMg

https://www.youtube.com/watch?v=YICS7mmEDxU&list=TLGGAgn5TNXgXywwODA4MjAyMg

Module 11 Reading: Specialty Stem Insertion-BFX Collared & BFX Lateral Bolt

Modifications of the standard BFX stem were designed for use in selected patients. Significant subsidence or torsional rotation of a stem can lead to catastrophic complications after surgery. Both implant modifications were developed to provide increased stability to resist subsidence and torsional rotation of the stem during the early postoperative period while bone ingrowth is occurring. The Lateral Bolt stem resists both subsidence and rotation, whereas the collared stem only resists subsidence. These stems are generally indicated in large dogs and dogs with stovepipe femoral morphology or in cases where there may be an increased risk or concern for stem stability in the early postoperative period. The implantation of an augmented BFX stem must still meet the criteria previously described for any BFX implant: a press-fit must be achieved. If press-fit stability is not achieved, or if bone quality is poor neither the collar nor the bolt will enhance fixation. If you are unable to attain press-fit stability because of poor bone quality, the best choice is to switch to a CFX stem. Preparation of the femur for both the Collared and Lateral Bolt stems is the same as that previously described for a standard BFX femoral implant.

BFX Collared Stem

The Collared BFX stem has a collar protruding from the medial aspect of the standard BFX stem (Fig 11-1). The collar is designed to resist stem subsidence in the early postoperative period. The Collared BFX stem is inserted and impacted into the prepared femoral bed, achieving a stable press-fit. Ideally, when the implant is fully impacted and has achieved press-fit, the collar is 1-2 mm short of resting on the medial cortical wall at the level of the femoral osteotomy. It is expected that during the early postoperative period, the implant may settle 1-2 mm such that the collar comes to rest on the bone aiding in implant stability while early bone ingrowth occurs (Fig 11-2). Note of caution: Press-fit must be achieved before the collar contacts the osteotomy, and a 1-2 mm gap remains between the collar and the bone. If there is no gap when the stem is press-fit, it may be necessary to place a larger stem if possible or lower the osteotomy so that a 1-2 mm gap exists.

Fig 11-1 BFX Stem and BFX Collared Stem

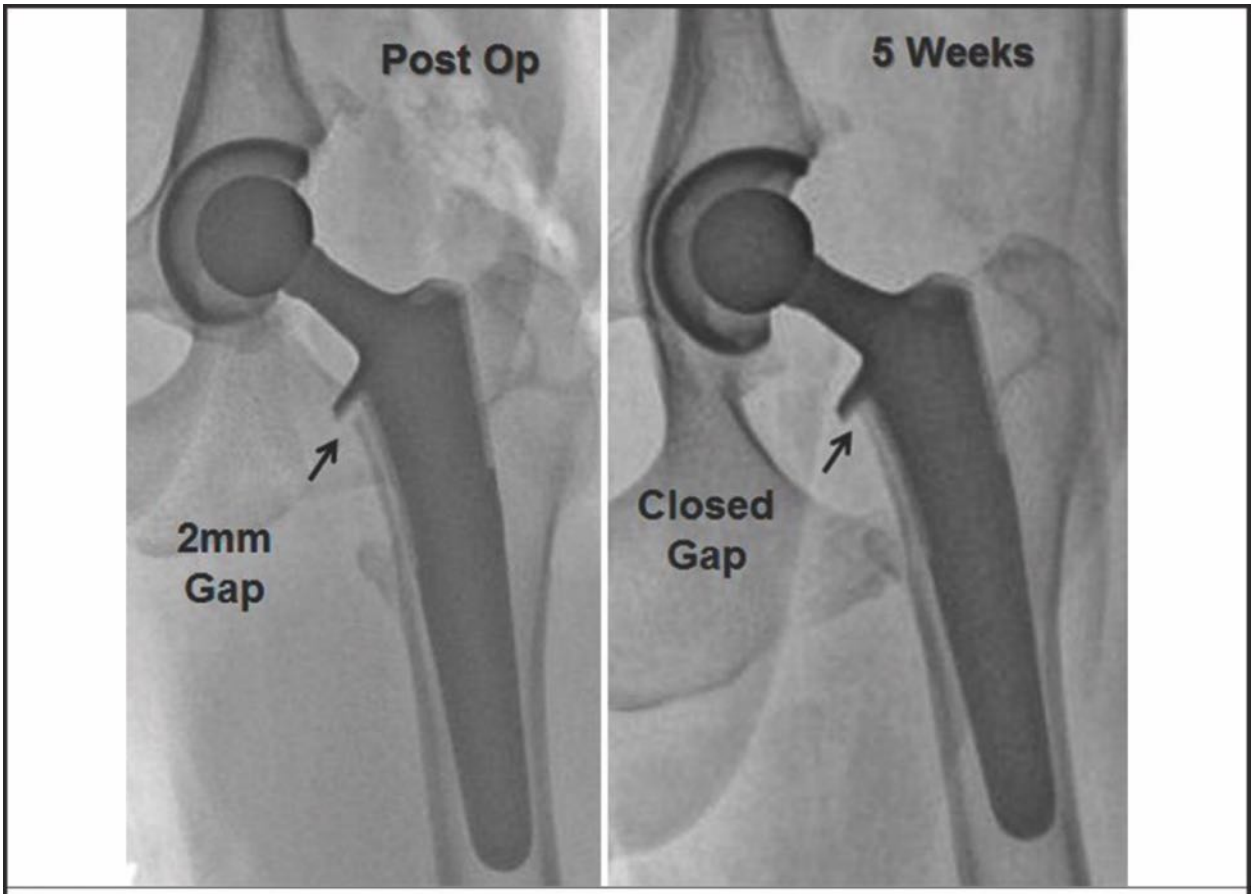


Fig 11-2 Collared BFX Stem Postop & 5 Weeks Postop

BFX Lateral Bolt Stem

The geometry of the Lateral Bolt BFX stem is identical to the standard BFX stem but has a guide hole drilled down through the neck exiting on the lateral side of the implant (Fig 11-3). A titanium bolt is passed through a window created in the lateral femoral cortex and threaded into the lateral surface of the stem and locked in place. The end of the bolt extends out through the lateral femoral cortex upon final seating (Fig 11-4). The bolt provides an additional point of fixation to increase resistance to implant subsidence and rotation in the early postoperative period. The Lateral Bolt BFX stem is inserted into the femoral canal similar to a standard BFX stem. A trial reduction must be performed to ensure that you can reduce the joint before drilling the hole for the lateral bolt. If you are unable to reduce the joint, even with a zero head, you have several options. You can try to cautiously impact the stem deeper into the canal to effectively reduce the neck length. If that is not possible, remove the stem from the femoral canal and carefully broach more deeply using the same size or one size larger broach for seating the implant deeper in the canal. Another option is the osteotomy can be cut 1-2 mm lower and broached to allow the stem to be seated lower in the canal. If you can reduce the joint, but the joint tension is too loose even with a +6 head, you need to increase the stem size. In this case, if it is possible based on preoperative templating, remove the stem and broach the bone bed up to

the next larger size stem.

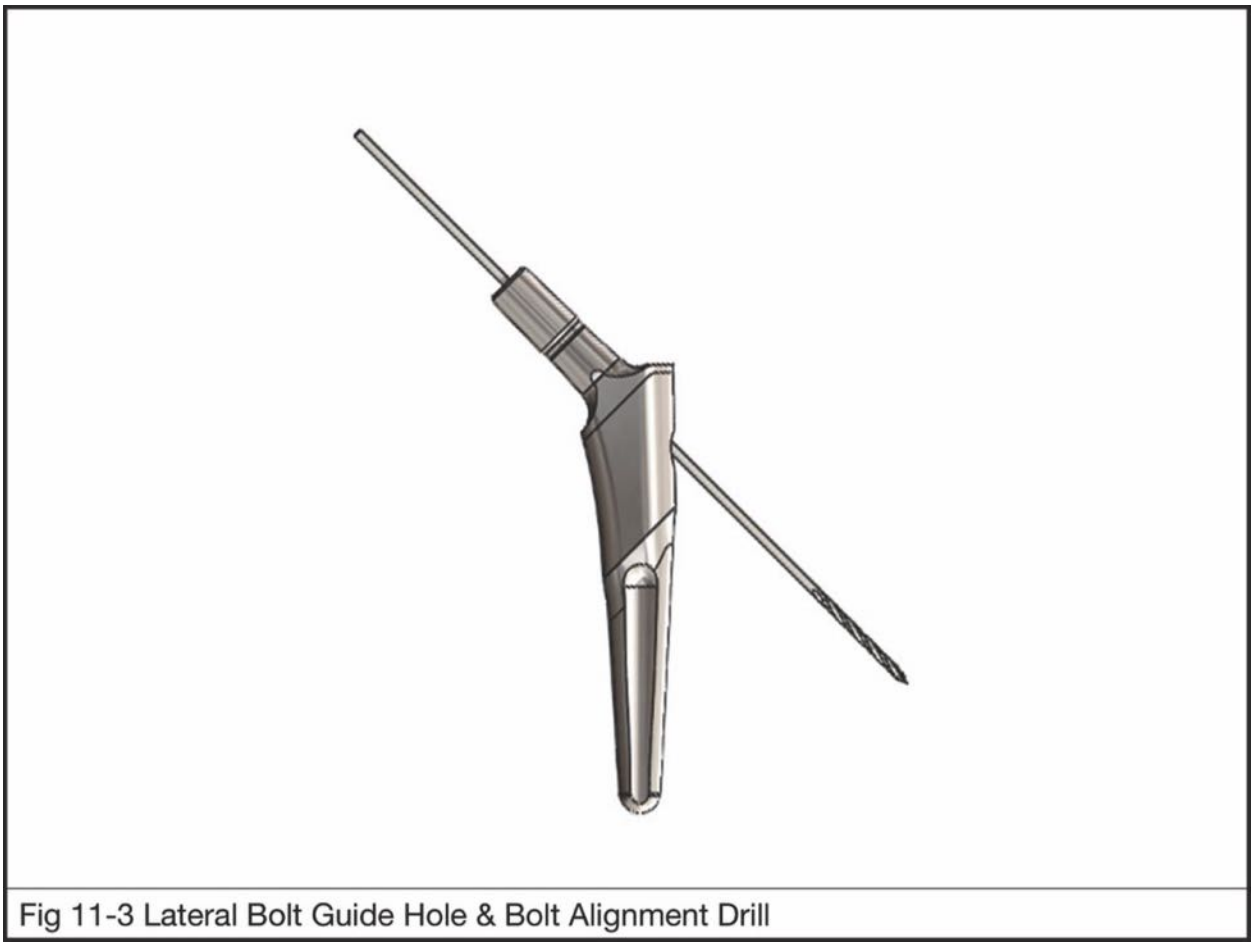


Fig 11-3 Lateral Bolt Guide Hole & Bolt Alignment Drill

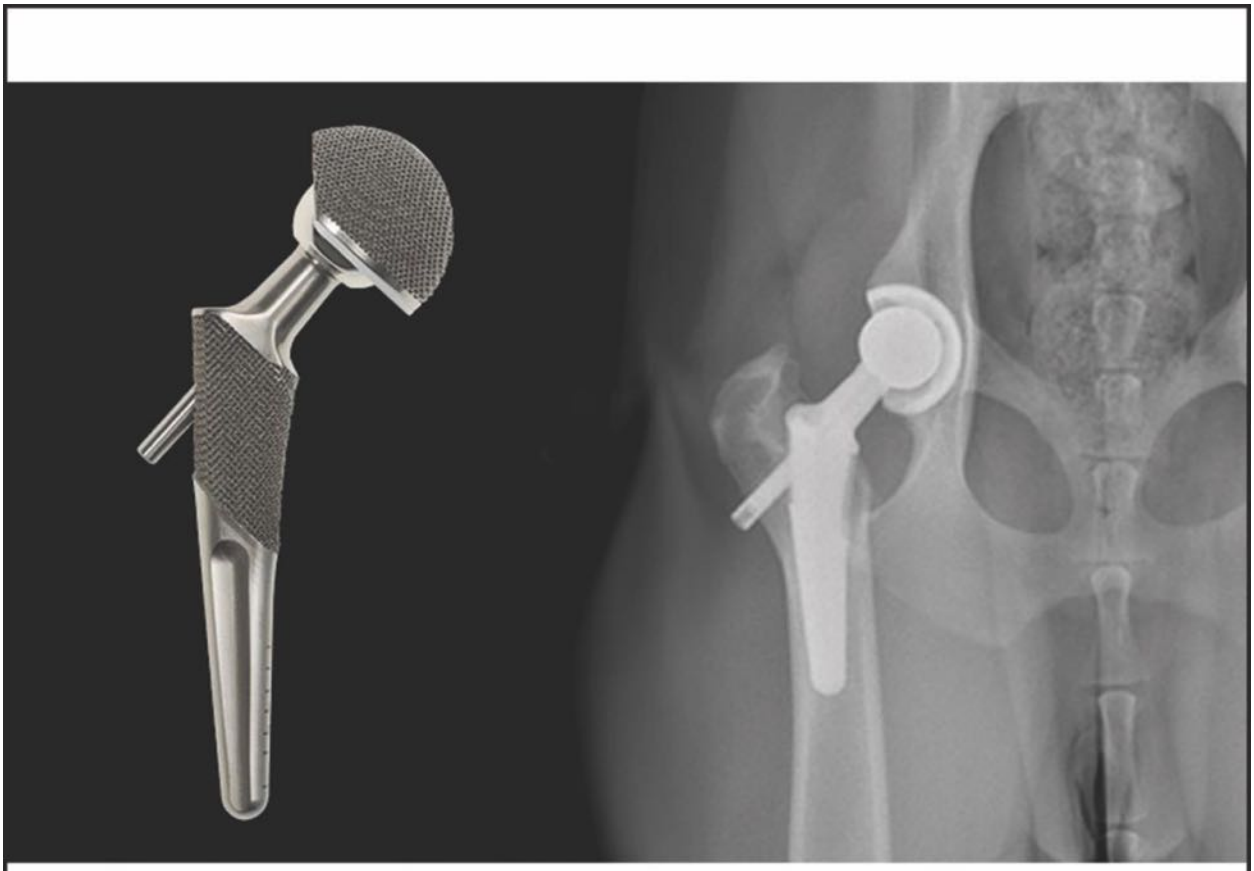


Fig 11-4 Lateral Bolt Stem and PO Radiograph

To insert the bolt, the femur is externally rotated, and a drill is inserted into the cannulated neck and bored out through the lateral cortex of the femur just distal to the base of the greater trochanter (Fig 11-3). When drilling, it is recommended that you approach and enter the femoral cortex slowly because the small flexible drill bit can deflect and place the hole in the incorrect location. Following removal of the drill bit, a 0.062 K-wire is placed through the neck, leaving a few millimeters of pin exiting the lateral femoral cortex. The pin is cut flush with the femoral neck of the implant, and a temporary femoral head is placed on the trunnion (Fig 11-5). This unique trial head stops the pin from migrating out of the neck and damaging the cup during the next step. Using a cannulated drill bit guided over the K-wire, the opening in the lateral femoral cortex is enlarged, creating a tunnel directed towards the lateral edge of the implant (Fig 11-6). The tunnel is cleared of bone debris down to the lateral aspect of the implant, by hand, using an awl and by pulsatile lavage. Before insertion of the bolt, the pin must appear centralized within the opening created in the lateral cortex of the femur. If the pin is not in the center of the hole, the bolt will not align properly or thread into the stem. If this is the case, the awl or a small curette can be used to remove the bone in the area of interference until the bolt can be freely inserted into the stem and seated.

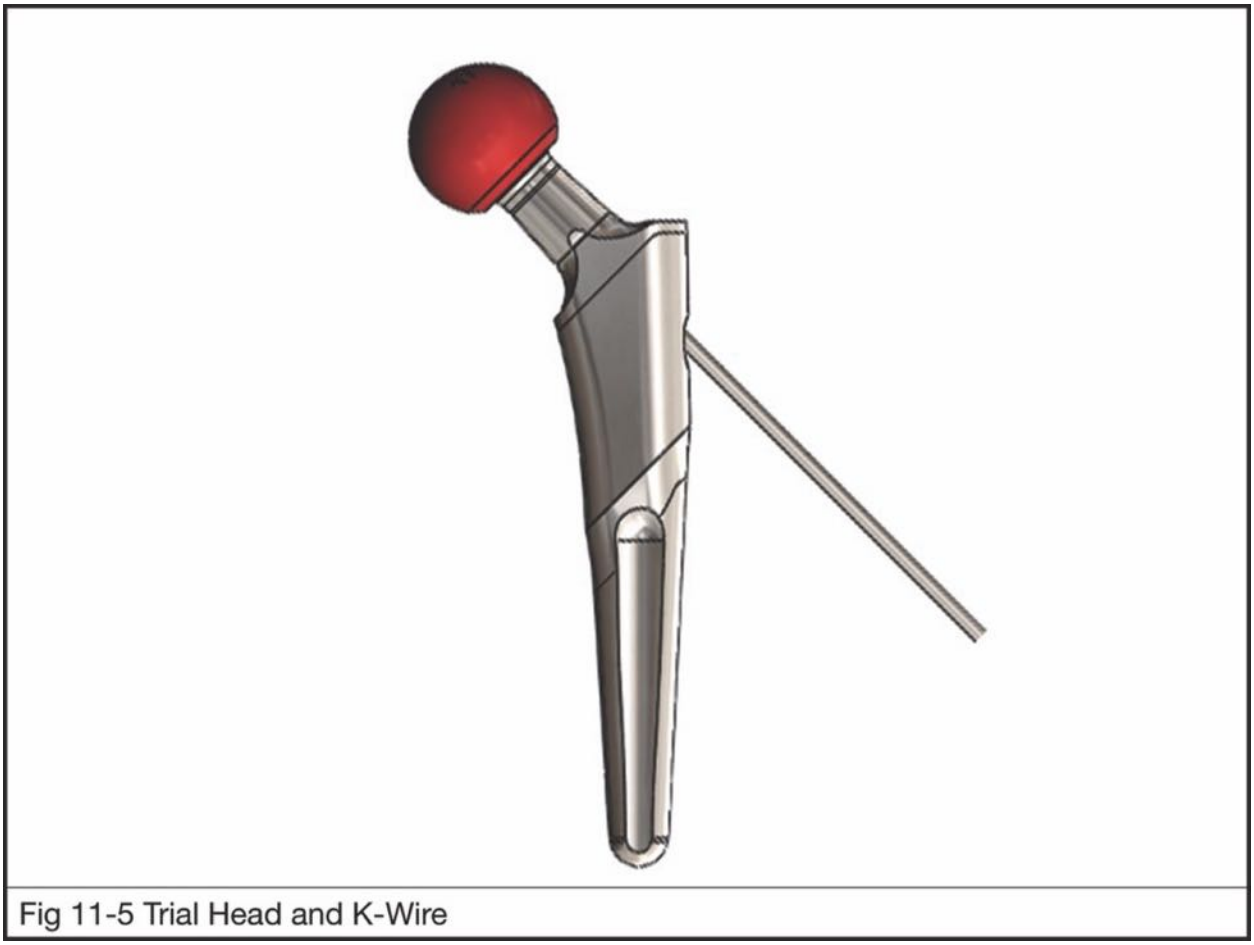


Fig 11-5 Trial Head and K-Wire

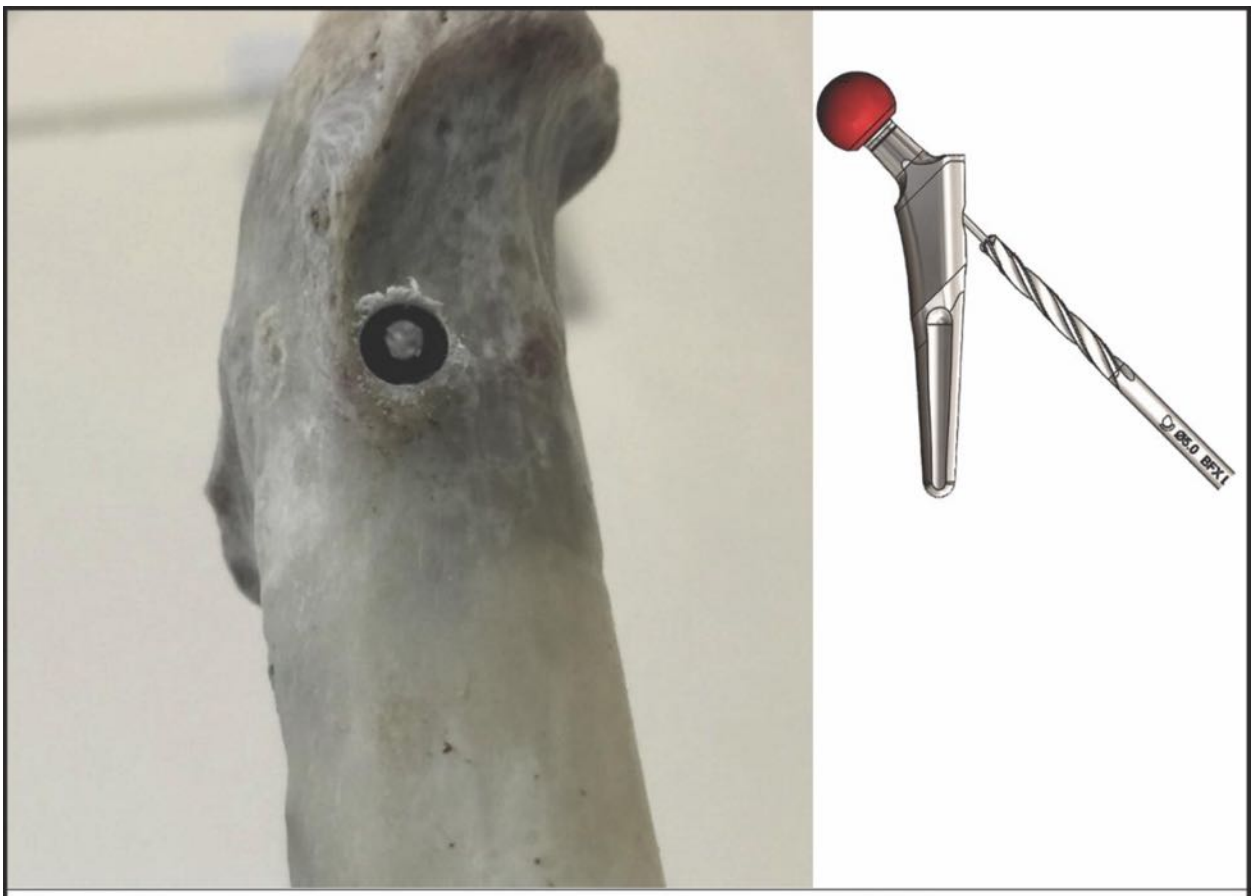


Fig 11-6 Tunnel in Lateral Cortex of Femur with Cannulated Drill Bit

The length of the tunnel is determined using the bolt gauge (Fig 11-7). The bolt gauge is inserted through the lateral cortex and into the stem. The bolt gauge will bottom out inside the stem. Push the gauge sleeve until it touches the periosteal surface of the lateral cortex and note the depth on the bolt gauge to determine the appropriate size bolt. The appropriate length bolt should leave 2-3 mm of the bolt extending beyond the lateral cortex when fully seated. The bolt is inserted through the cortical opening towards the implant (Fig 11-8). When fully inserted, the bolt is tightened into the threads within the implant until a firm endpoint is met. Lateral Bolt stems and bolts are available in a variety of sizes and lengths to meet individual patient needs (Fig 11-9). The remainder of the surgical procedure with these augmented stems is as previously described for a standard BFX implant.

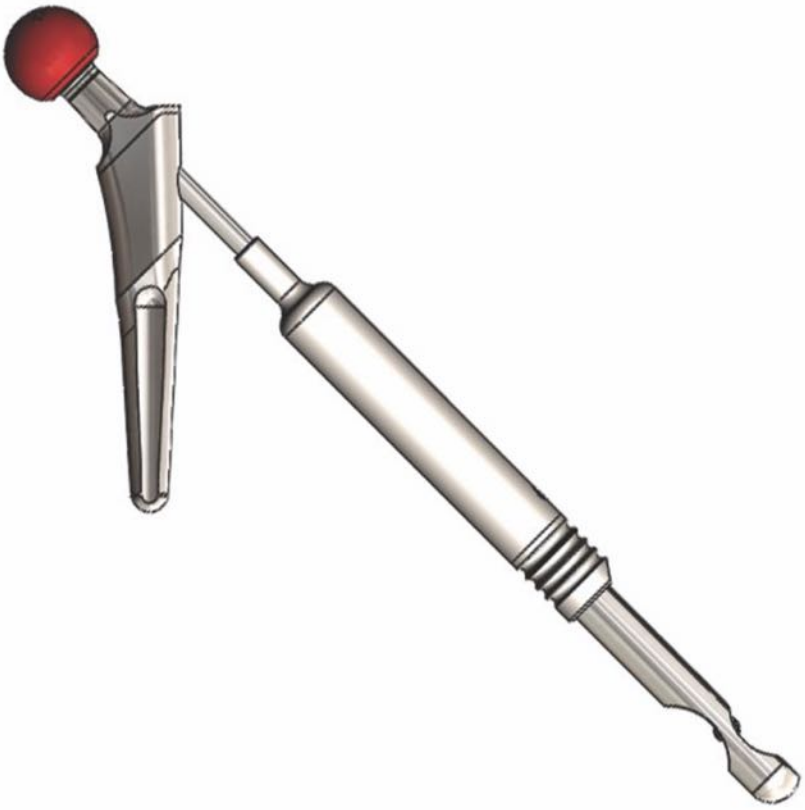
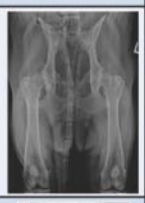
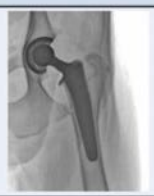
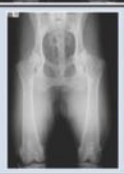
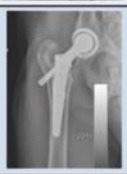


Fig 11-7 Bolt Gauge

Fig 11-8 Bolt Insertion

Fig 11-9 BFX Lateral Bolt Stem and Instrument Set

Figure 11-10 illustrates the BFX Collarless, Collared, and Lateral Bolt stems, including their indications and limitations.

Product	Photo	Indications	Example Rad.	Limitations/Precautions
BFX® Collarless		• Hip OA • Hip trauma • Hip dysplasia		• Large breed dogs with CFI < 1.8 • Femur with thin cortices • Femur with poor quality cancellous bone 
BFX® Collared		• Large breed dogs with CFI < 1.8 • German Shepherds with thin cortices • Cancellous bone strength must be adequate for supporting stem for all indications 		• Stem should be tight prior to seating or left slightly proud having achieved the fit prior to collar seating • If collar seats and stem fit in question, stem must be removed and neck resection lowered and stem re-impacted.
BFX® Lateral Bolt		• Large breed dogs with CFI < 1.8 • German Shepherds with thin cortices • Cancellous bone strength must be adequate for supporting stem for all indications 		• Very thin cortices in combination with poor quality cancellous bone may not be able to prevent stem subsidence • Attention must be paid to the drilling prep of the bolt to assure alignment for insertion.

*It is **important** the surgeon has **sufficient experience** with **press fitting** femoral stems and gauging the **strength of the cancellous bone** through the broaching steps. That experience is the **common denominator** for success in the use of all these stem designs. The feedback during sequential broaching provides the insight to implant stability, and the understanding to move to a cemented procedure when sufficient resistance to support a non-cemented stem does not exists.*

Fig 11-10 Clinical Indications for BFX Collarless, Collared & Lateral Bolt Stems

https://www.youtube.com/watch?v=FPxKKfrnnfA&list=TLGGc4KiNqTAZyEwODA4MjAyMg

https://www.youtube.com/watch?v=o4z87ReZtgU&list=TLGGtOkM6MrIehcwODA4MjAyMg

Module 12 Reading: Trial Reduction

Trial reduction is performed with trial heads to determine the reduction tension of the joint. The reduction tension should not be excessively tight or loose. Proper alignment of the cup and impingement free range of motion are more important in maintaining reduction than joint tension. Trial reduction generally begins with the +0 mm Trial Head and is then adjusted upward based on the reduction tension. As a matter of choice, some surgeons prefer to start the trial reduction with a +3 mm head and then adjust the neck length either up or down. During trial reduction, with the reduced joint held in a normal walking position, you should be able to assess if the retroversion of the cup matches the anteversion of the stem. With the limb in this position, the flat surface on the back of the femoral head component should be parallel with the plane of the face (non-truncated aspect) of the cup (Fig 12-1). Or another way to look at it is, with the limb held in a neutral walking position, there should be relatively equal amounts of femoral head visible cranially and caudally. Some inferences regarding cup positioning can be made from postoperative radiographs, however, the best indication you will get of cup positioning, especially with the metal backed BFX cup, will be intraoperatively. If a BFX or CFX cup is determined to be misaligned during trial reduction, it is far better to remove the cup and its orientation corrected during the initial surgery rather than at a later date when a dislocation occurs.

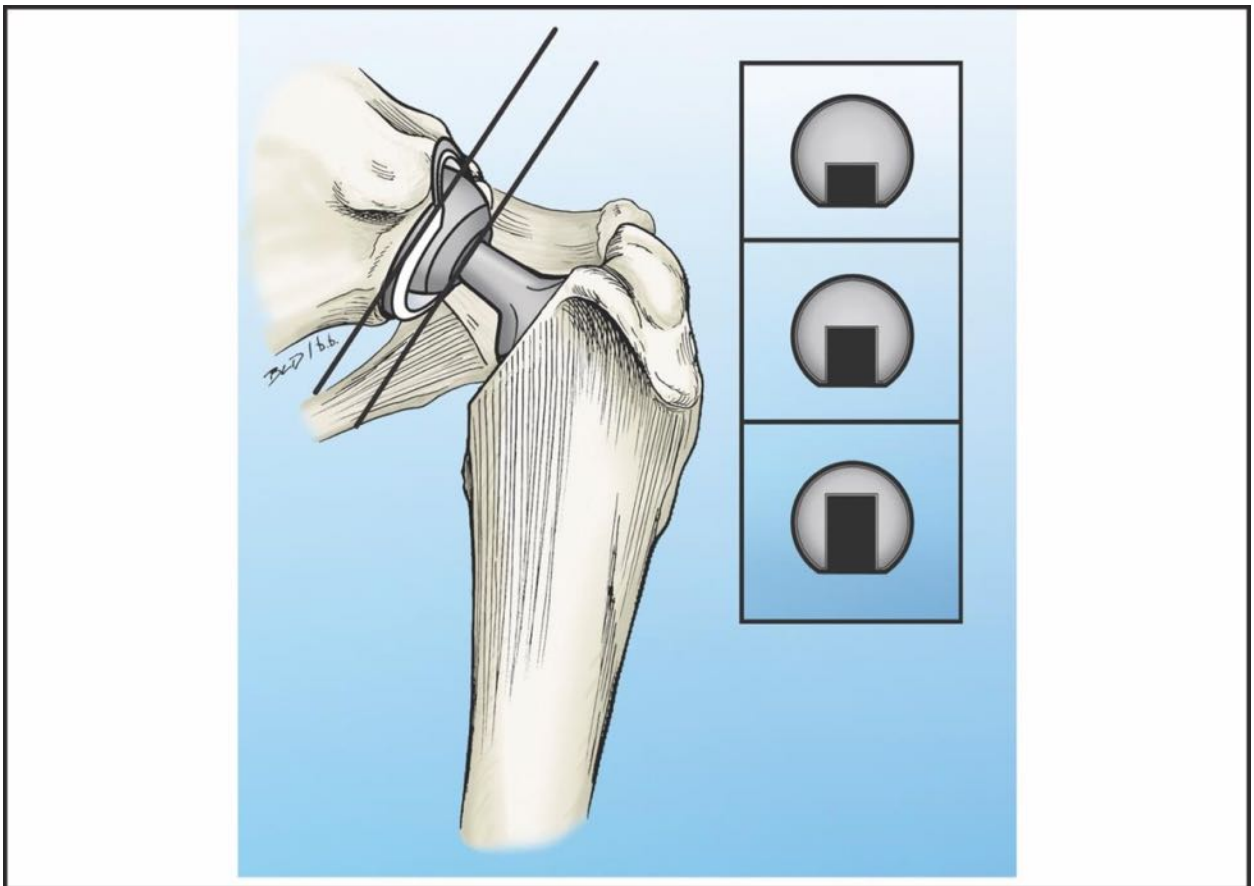


Fig 12-1 Trial Reduction

During trial reduction the range of motion should be checked, particularly external rotation, full flexion and abduction. If external rotation is limited, the caudal area of the cup and acetabular bone bed should be checked for interference or impingement with the femoral neck. Correction of impingement is better done before final head assembly, with the joint luxated. If large osteophytes or bone on the rim of the acetabulum interfere with the range of motion, or are acting as a fulcrum resulting in luxation, they are removed with a rongeur. Similarly, large osteophytes present on the caudal aspect of the greater trochanter should be removed. Lengthening the femoral neck may also increase the range of motion. When removing the Trial Head from the trunnion, the head should be firmly grasped with the fingers to prevent loss in the wound.

Module 13 Reading: Head Assembly, Reduction and Closure, Postoperative Radiographs, Postoperative Management

HEAD ASSEMBLY

The trunnion is first wiped free of blood and fat and dried before attachment of the head. The head, with the appropriate neck length, is placed onto the trunnion and impacted with the Mallet using the Head Impactor (Fig 13-1). Caution must be taken to prevent contact of the head component with any metal instruments or the rim of the metal acetabular shell during placement or during reduction to avoid scratching the head surface. It is recommended that a gauze be placed between the Head Impactor and the bearing surface to prevent scratching.

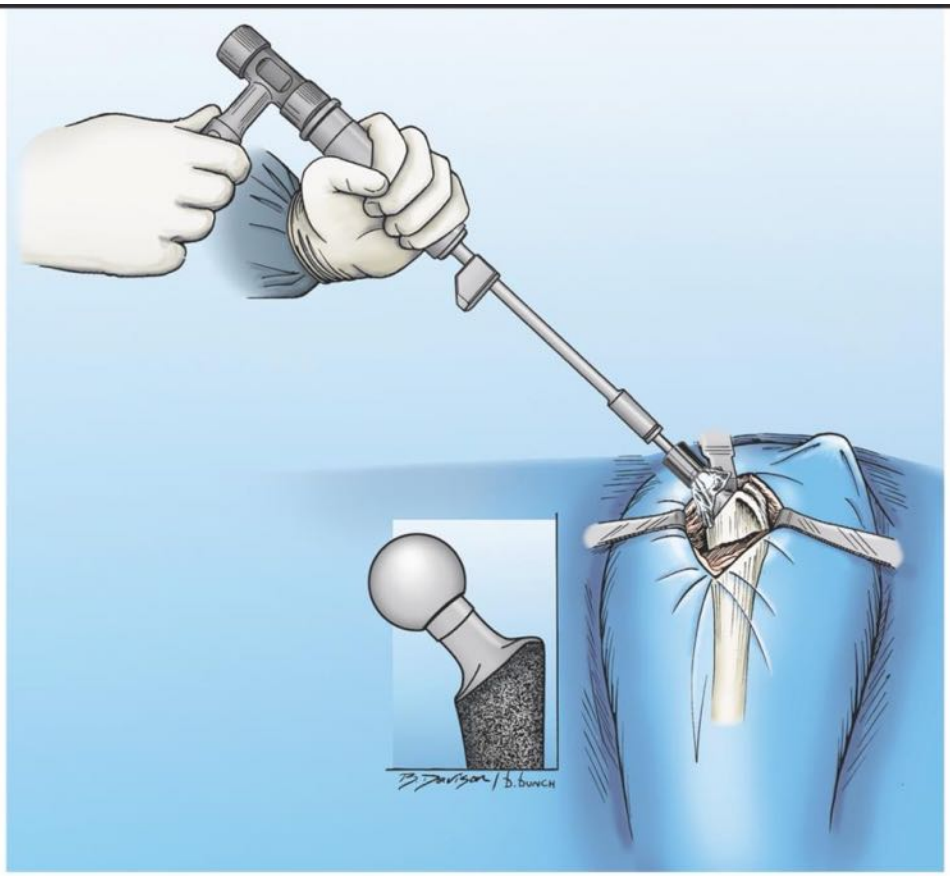


Fig 13-1 Head Impaction

REDUCTION AND CLOSURE

The femoral head is reduced into the acetabular cup. The range of motion of the reduced joint is again evaluated. The joint and the wound are lavaged copiously with pulsatile irrigation. The joint and adjacent tissues are carefully inspected and if bone cement has been used, any remnants of cement are removed. The wound is closed in layers, beginning with the joint capsule. The transected tendon of the deep gluteal muscle is reattached securely by suturing the two ends. The reflected vastus lateralis muscle is sutured to its origin or, if necessary, to the ventral edge of the tendon of the deep gluteal muscle. The overlying tissues are closed in layers.

POSTOPERATIVE RADIOGRAPHS

Regardless of the type of components (CFX or BFX) implanted, postoperative radiographs are made using the same four positioning techniques as described for the preoperative assessment and templating (Fig 13-2 -13-9). All follow-up radiographs should use the same positioning to allow serial radiographic assessment of the prosthetic components and the bone remodeling.

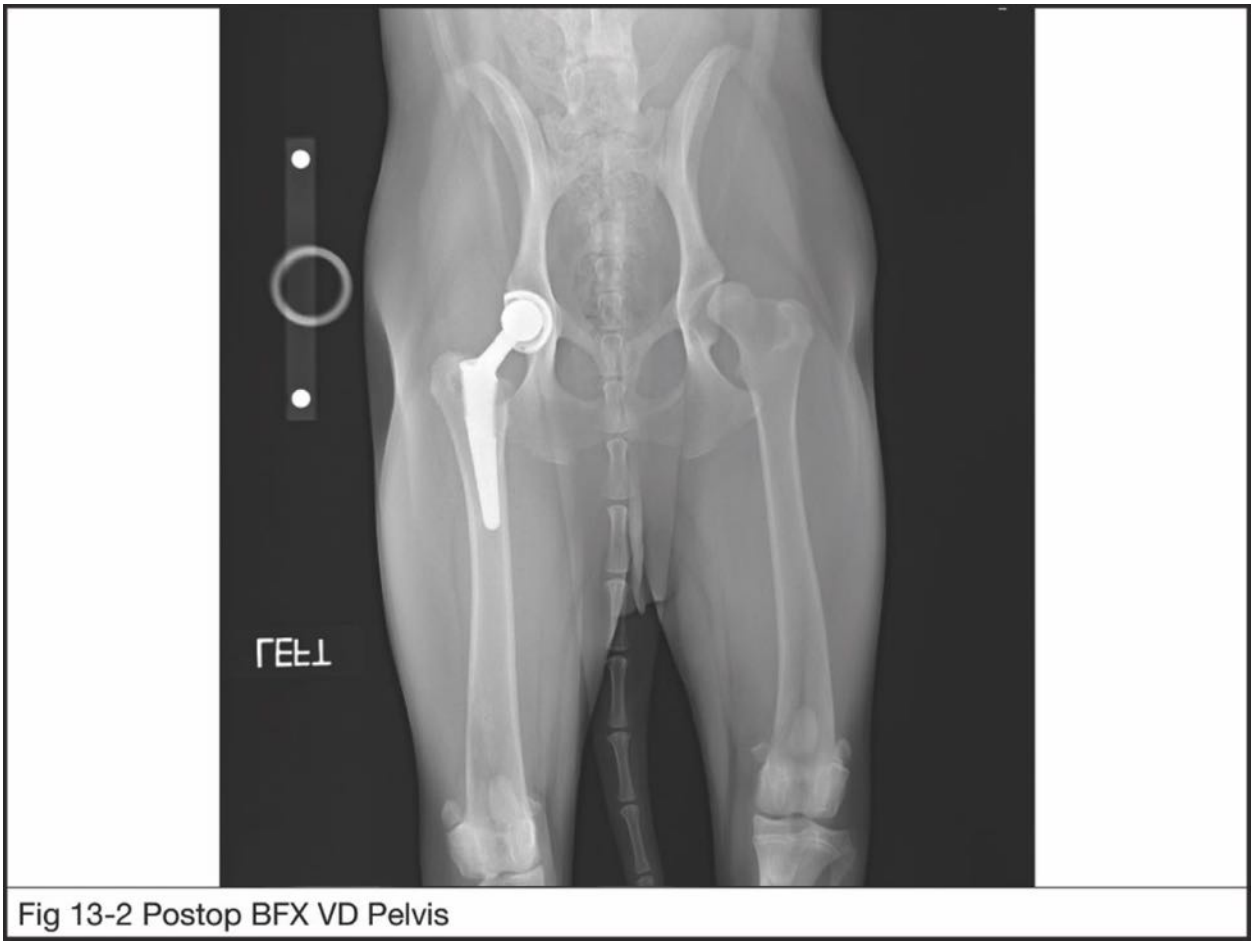


Fig 13-2 Postop BFX VD Pelvis

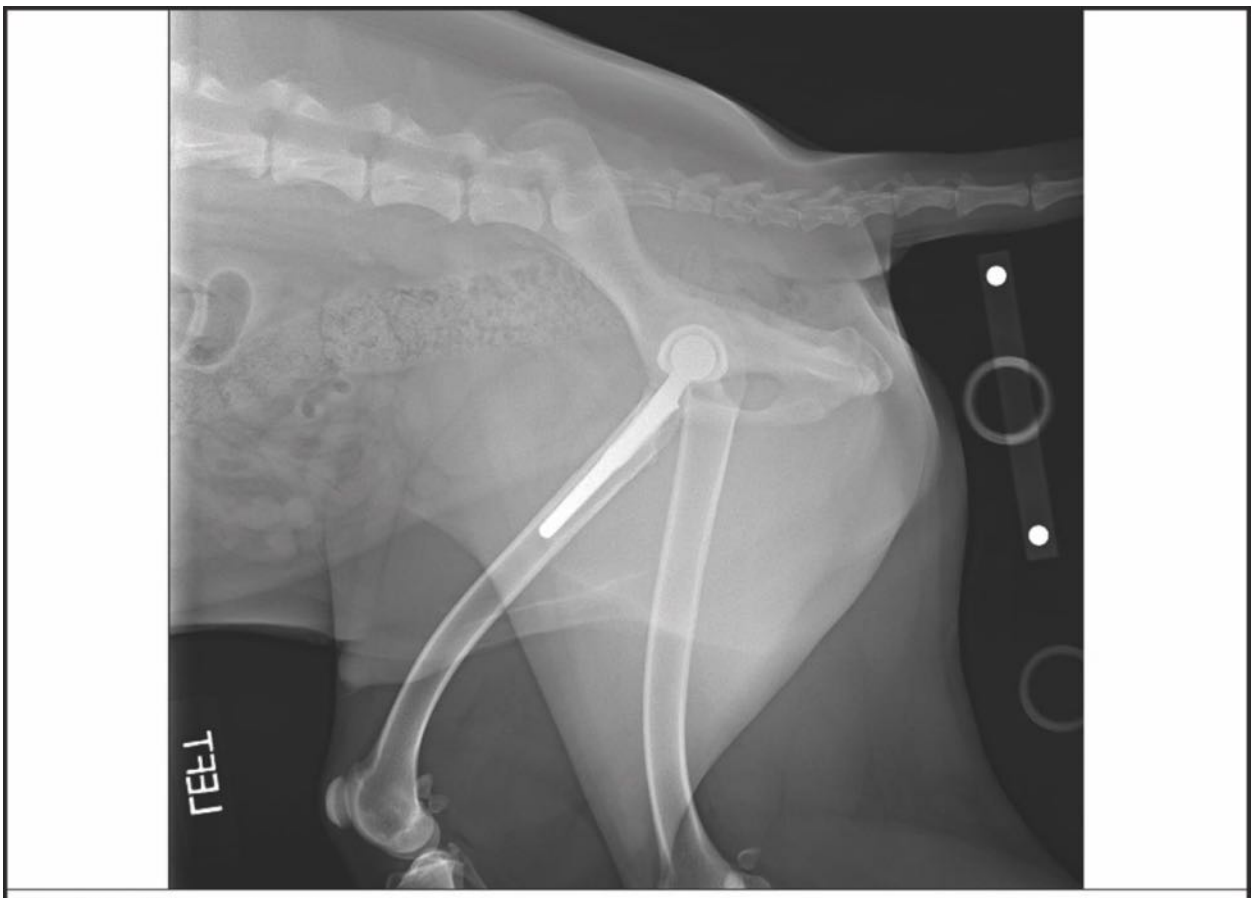


Fig 13-3 Postop BFX Lateral Pelvis

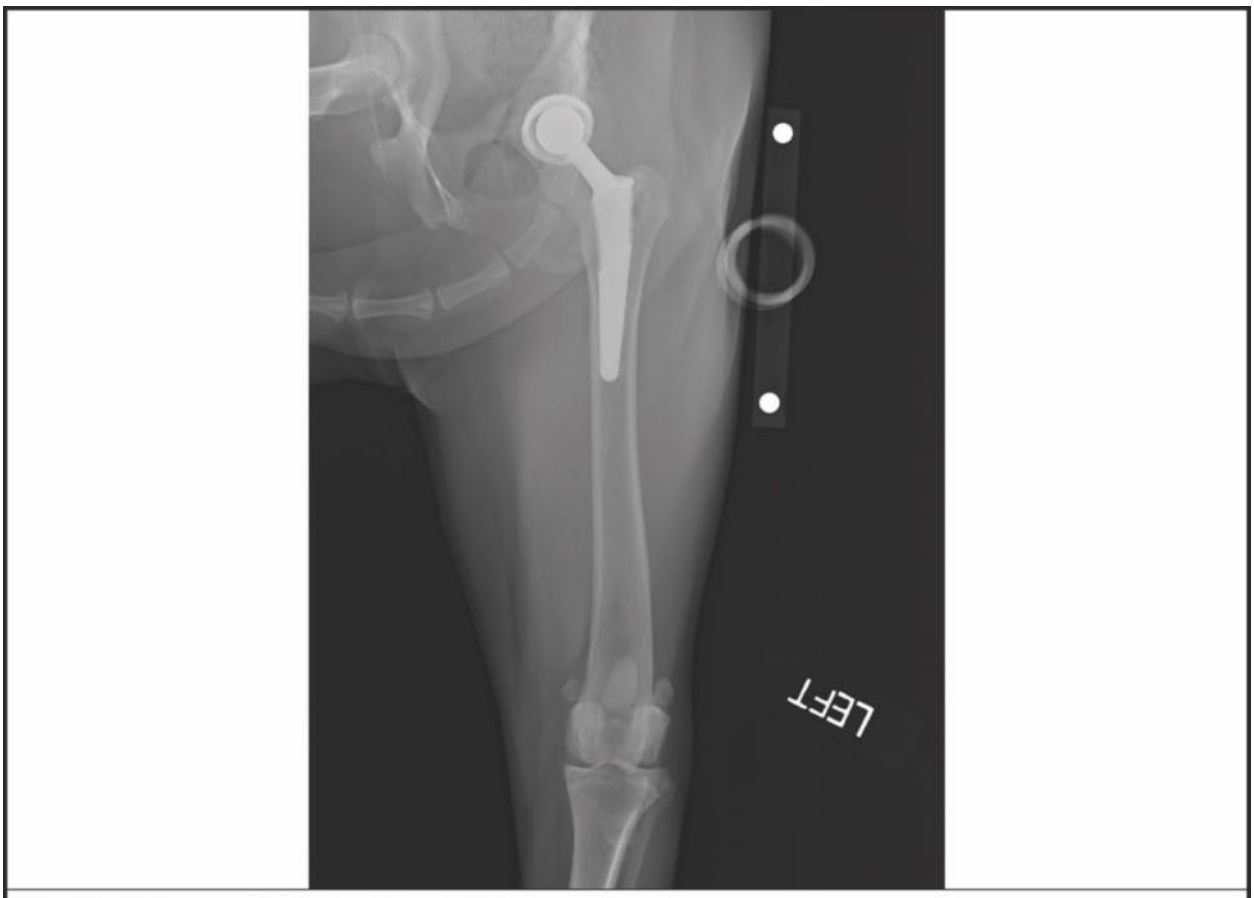


Fig 13-4 Postop BFX Craniocaudal Femur

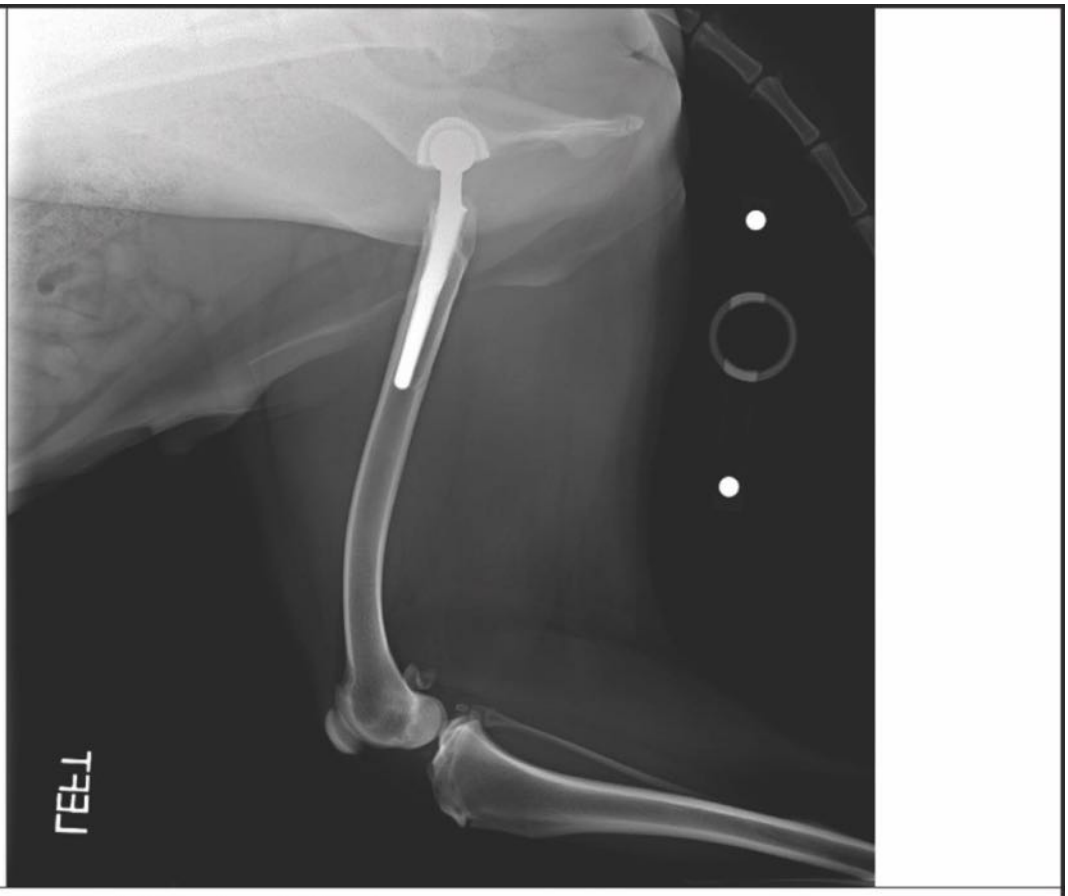


Fig 13-5 Postop BFX Open-Leg Lateral

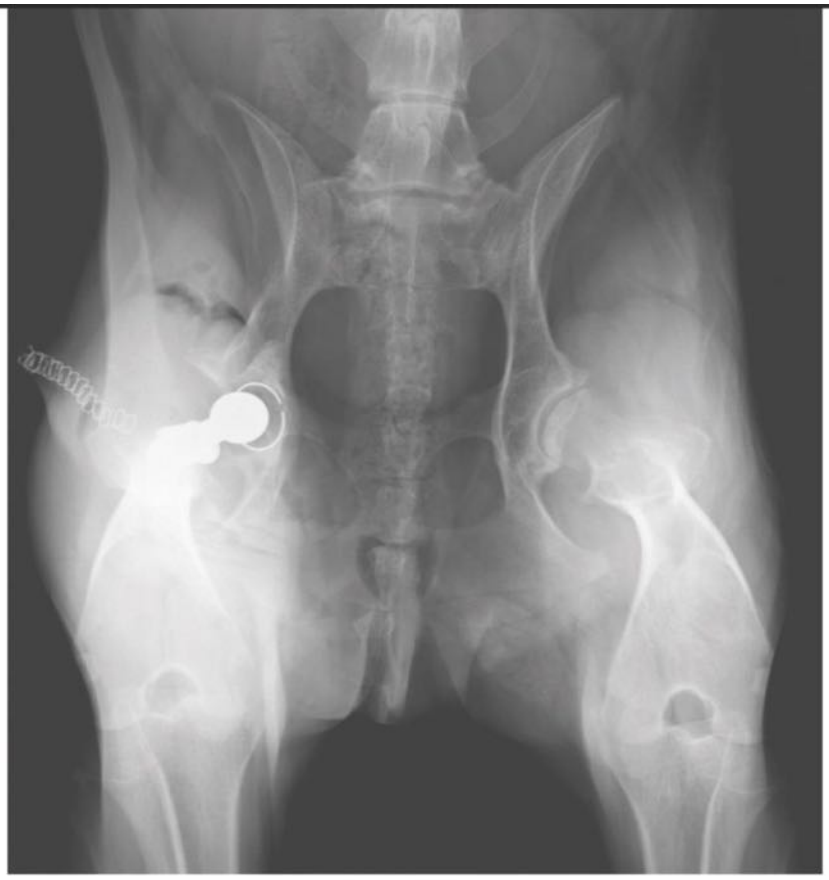


Fig 13-6 Postop CFX VD Pelvis

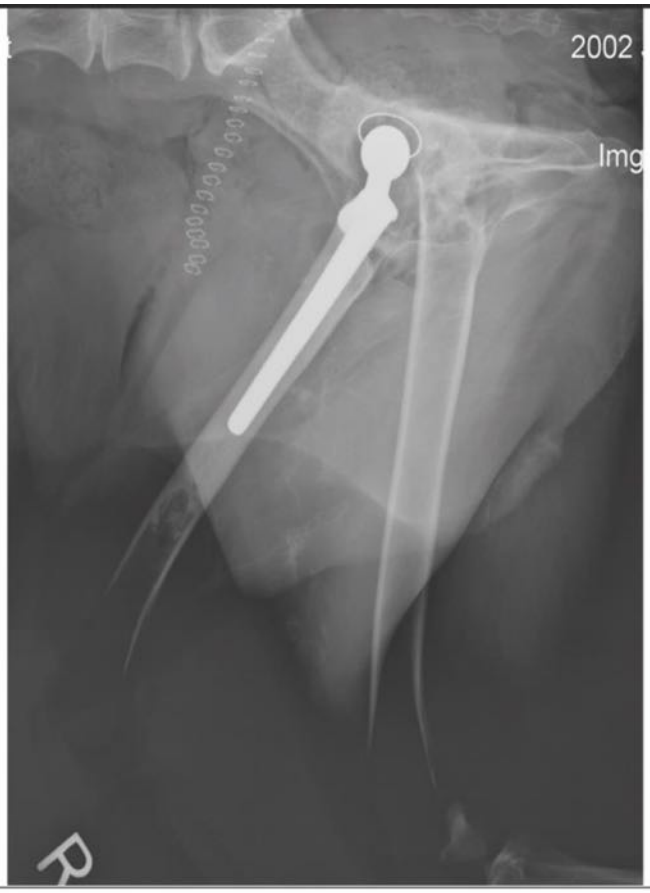


Fig 13-7 Postop CFX Lateral Pelvis

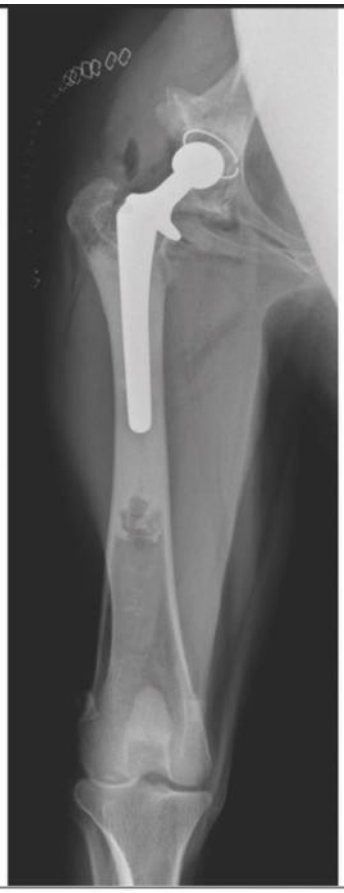


Fig 13-8 Postop CFX Craniocaudal Femur

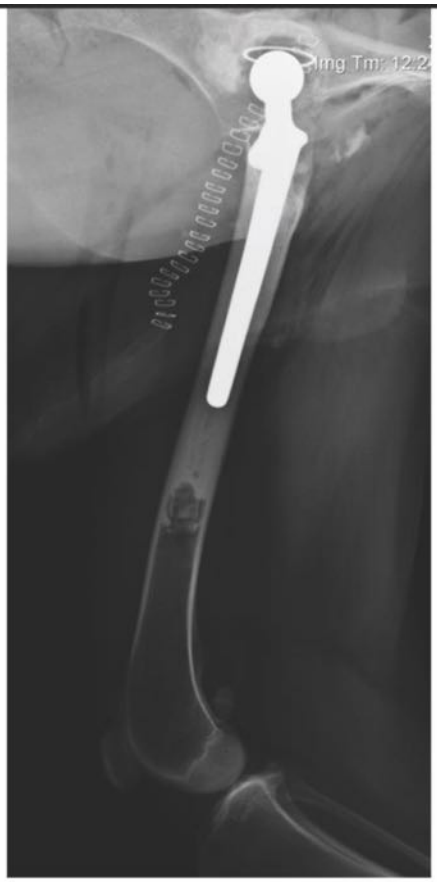


Fig 13-9 Postop CFX Open-Leg Lateral

https://www.youtube.com/watch?v=n3Vq7-CY6dQ&list=TLGGKk8X8153a0swODA4MjAyMg

POSTOPERATIVE MANAGEMENT

Recovery from anesthesia should be in a cage or run with a non-slip surface. Full weight-bearing is allowed immediately but supporting the rear quarters with a sling during hospitalization and the early postoperative period is recommended, especially when the patient is on smooth surfaces or stairs. Clients should be instructed to minimize stairs and avoid slippery surfaces if possible. They must have direct control of the dog with a leash or belly sling during the postoperative recovery period. Exercise for the first 8 weeks is restricted to short leash walks only, then slowly increased over the following 4 weeks. Vigorous activity is avoided until after 12 weeks following surgery. These recommendations can always be modified after the first postoperative follow-up at 8 weeks after surgery. Before the follow-up evaluation, it is best to maintain contact with the client immediately following discharge from the hospital and during the first few weeks at home to ensure that adequate progress is occurring. The client should be informed that it is expected the dog will be weight-bearing and improving steadily. If the patient

prefers to carry the leg, toe touch only or becomes suddenly worse, the client should notify your office. Patients that are not using the leg or have stopped using the leg acutely, need to be reevaluated. A patient is at most risk for dislocation or unexpected implant position changes during the trip home from the hospital and during the first few weeks at home with family and other pets. If complications happen, they can be more easily managed early rather than at 8 -12 weeks following surgery, especially after bone in-growth has occurred in a BFX implant.

Module 14: Removal of Cemented CFX Stem or A Fully Ingrown BFX Stem

Stem: Removal of a fully ingrown stem or cemented stem can be a challenging procedure and takes an aggressive technique and experience. Although no one likes to remove prostheses, it is a procedure that all surgeons performing total hip replacement will face and the procedure must be learned. Revision of a failed prosthesis is even more challenging. Referral or consultation with a surgeon experienced with revision surgery should be considered in these cases.

The approach to stem removal will vary between a BFX and a cemented stem. The start of all stem extractions must begin with removal of the bone at the top of the stem to provide a pathway for the stem or stem and cement mantle to exit.

For removal of a CFX Stem, a large dull osteotome, positioned under the collar of the implant, can be used to drive the prosthesis out of the bone or the cement mantle. Alternately, the Stem Extractor Slap Hammer can be attached to the femoral neck for stem removal. Complete removal of the medullary cement mantle is generally recommended with CFX Stem removal. A lateral femoral window procedure has been described which allows access to the medullary canal of the femoral diaphysis for cement removal (Fig 14-1 & 14-2). If access to the proximal portion of the femur is required as well, a sliding trochanteric osteotomy can be performed. Saw cuts through the femoral cortex cranially and caudally along the greater trochanter are made. These cuts can be curved together at a common point distally on the lateral side of the bone just distal to the base of the trochanter or extended further distal if necessary. The trochanter is then elevated to allow access to the femoral canal for implant and cement removal.

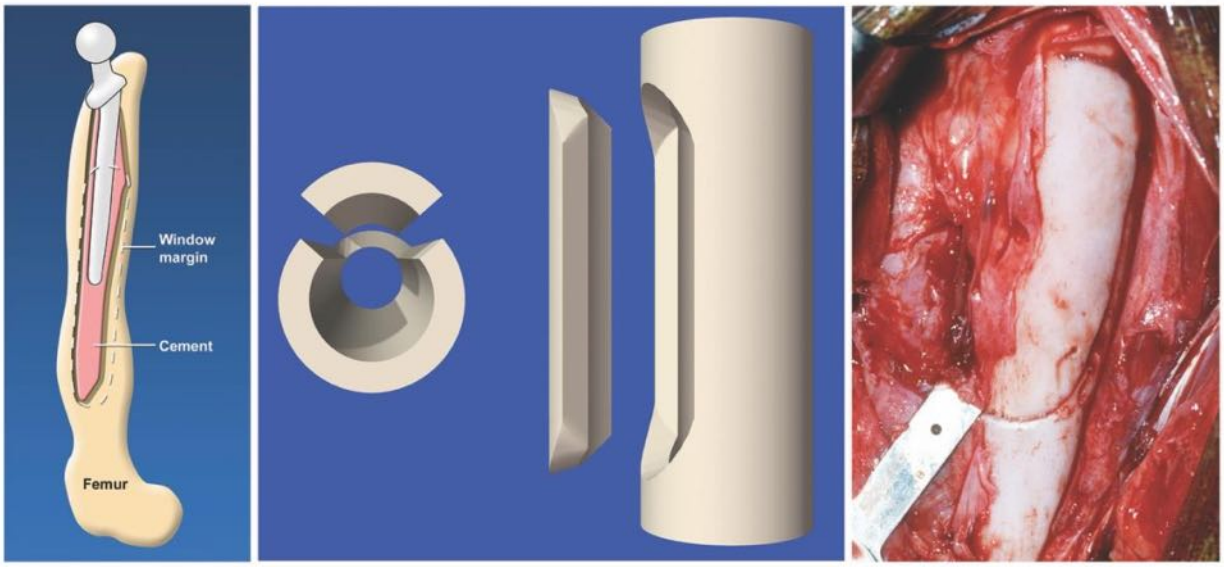


Fig 14-1 Lateral Femoral Coffin Lid

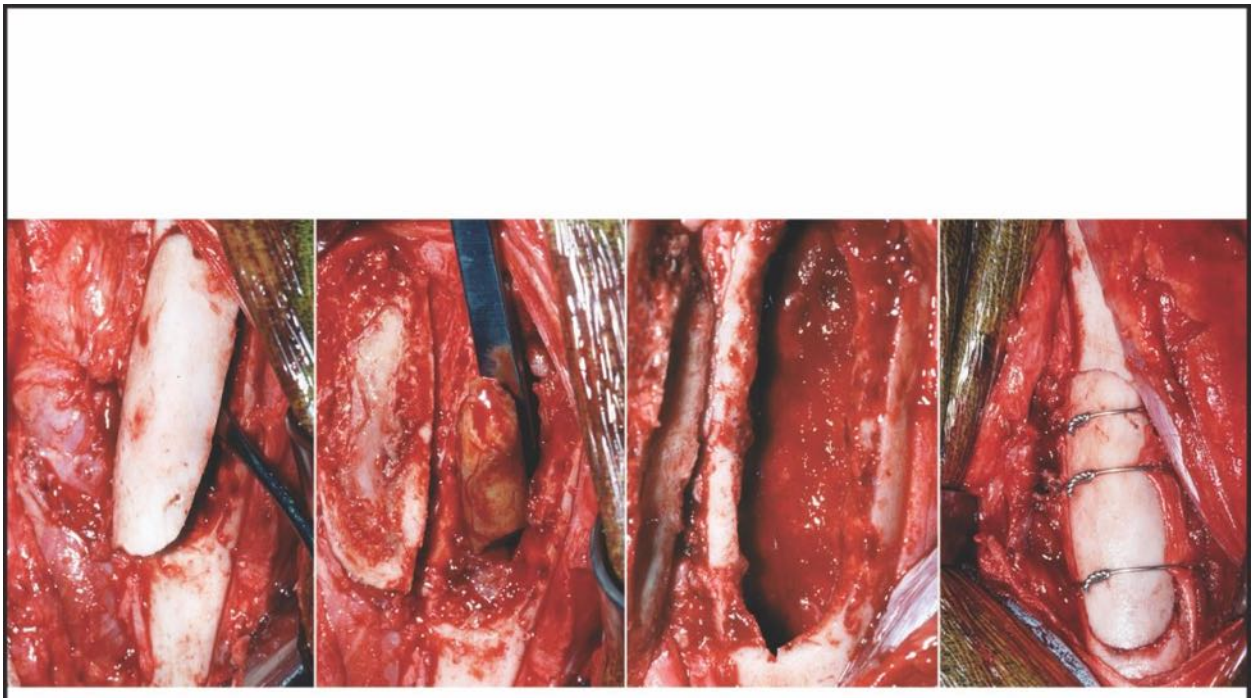


Fig 14-2 Lateral Coffin Lid into Femur to Remove Bone Cement

For removal of a fully ingrown BFX stem, the interface between the porous portion of the stem and the bone must be broken down using narrow, ultra-thin, flexible osteotome blades. Significant care must be exercised during osteotome use to minimize damage and weakening of the femoral bone. Remodeling loss or thinning of bone stock at the porous surface of the implant cranially can result in limited space for working an osteotome between the bone and the implant. Conservative, elective removal of bone in this area with a high-speed burr followed by circumferential disruption of the remainder of the ingrowth area may be required in some cases. This may leave a defect in the bone cranially making revision with another femoral stem, CFX or BFX, difficult to perform.

Cup: An ingrown BFX cup is removed by disrupting the bone implant interface with a flexible osteotome cranially, caudally and dorsally. Once the porous ingrowth has been broken down, the cup can be swiveled out ventrally by impacting the dorsal rim of the metal shell. Removing the polyethylene liner first may ease overall cup removal. Care should be taken to avoid excessive bone removal if a revision procedure is planned. Similarly, a CFX cup is removed by disrupting the cement-bone interface with an osteotome. Ideally all cement is removed from the acetabular bed. If both hip components are to be removed, the stem should be removed first to facilitate easier exposure for removal of the cup.

Module 15 Reading: Indications for THR and Case Selection

Total hip replacement can be used to alleviate the pain caused by a number of abnormal coxofemoral joint conditions. The most common of these conditions include non-septic degenerative osteoarthritis secondary to hip dysplasia, trauma and other developmental conditions. Hip luxations, capital physeal separation, femoral head and neck and acetabular fractures, avascular necrosis and select neoplastic conditions can also be managed with a THR procedure.

If appropriate, a conservative medical therapy plan should always be attempted before any THR procedure. Surgery should be reserved in most cases for those patients who did not tolerate a medical treatment plan or have persistent, poorly responsive or worsening pain despite medical therapy. A THR procedure is rarely an emergency.

A thorough physical examination is essential for all THR patients. It is important to rule out all other potential causes of rear limb lameness, such as stifle or neurologic disease. Also, you must confirm significant hip pain during the pre-surgical work-up. Contraindications for the THR procedure include obesity, pyoderma, neurologic conditions affecting ambulatory function, septic arthritis, coagulopathy, or overt renal, hepatic or cardiac organ diseases. Stifle instability, resulting from anterior cruciate ligament rupture should be resolved before a THR procedure on the same limb. Patellar laxity can often be addressed at the same time as a THR procedure or may be better treated and resolved before the THR procedure. Concurrent conditions that could affect healing, such as diabetes mellitus, Cushing's disease or immune-mediated polyarthropathy may be contraindications for a THR procedure. Rear limb amputees can undergo THR but require modifications during cup placement to compensate for the altered pelvic positioning these patients exhibit during weight-bearing.

Patient age is an important consideration in the surgical decision process. Once acetabular growth plate closure has occurred, a patient may be considered for a THR procedure. Often, a window of opportunity exists for patients 5-12 months of age with severe subluxation caused by hip dysplasia. In this group of patients, early surgical intervention is often best. Once remodeling changes in the bone and soft tissues occur the procedure becomes more difficult and the rate of complications higher. Also, advancing age may be associated with decreased bone quality and a higher risk of femoral fracture associated with surgery. The procedure in the older patient with severely advanced osteoarthritis can also be technically demanding because of the loss of available bone stock, sclerotic bone, periarticular fibrosis, muscle atrophy and contracture.

Overall, canine total hip replacement is challenging because of the range of sizes and shapes of bones, thin cortices and the extensive remodeling changes associated with advanced hip dysplasia. Success is generally related to case selection, or at the very least the ability to

recognize potential challenges preoperatively. When first starting to perform THR it is best to choose cases with relatively normal anatomy until you are comfortable with the procedure before venturing on to the more difficult cases.

In summary, we, the instructors for the BioMedtrix Universal Hip Course, encourage you to actively study and learn the information presented in this online prerequisite course. The next step to reinforce your learning this procedure is your participation in a hands-on surgical workshop. The workshop environment will allow you the opportunity to interact with us in an informal setting in small groups, and further reinforce the material you have covered in this course.

The following narrated video Canine Total Hip Replacement using the BioMedtrix Universal Hip System demonstrates the steps and techniques presented in this course and provides a preview of a surgical workshop.