Decision Making for and Risk of Total Joint Replacement for Dogs and Cats

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Canine total hip replacement (THR) has been performed with success for over 3 decades. Today the procedure is widely recognized as the best way to provide a pain free biomechanically sound hip joint for dogs suffering with pain from osteoarthritis and other arthropathies. Olmstead and colleagues developed and perfected the cemented modular prosthesis. DeYoung and colleagues developed the cementless modular prosthesis, which started as part of a comparative study and eventually became commercially available in 2003. Other prostheses are now available to the surgeon, but lack of extensive experience with those systems by the author limits this discussion to the BioMedtrix system, with over 1600 THRs performed as part of an ongoing prospective study.

There are advantages and disadvantages of both the cemented and cementless systems. In addition, there will always be some surgeon preference based on confidence or comfort with one system compared to the other gained through experience.

Widespread availability has extended surgeon options for indications and patient sizes. Satisfied clients, happy dogs, clients seeking the procedure, lack of equally successful alternatives, and revenue generated by the procedure has stimulated surgeon interest in becoming proficient at the procedure. A good understanding of the systems is necessary to make correct decisions about instrumentation and implant selection. The decisions should be based on points such as system versatility, the learning curve on technical difficulty, risk and complication rate, individual case variation, different indications, aftercare requirements, patient function, and client satisfaction. Information available is subjective in some regard, but objective gait analysis is published that documents successful results.

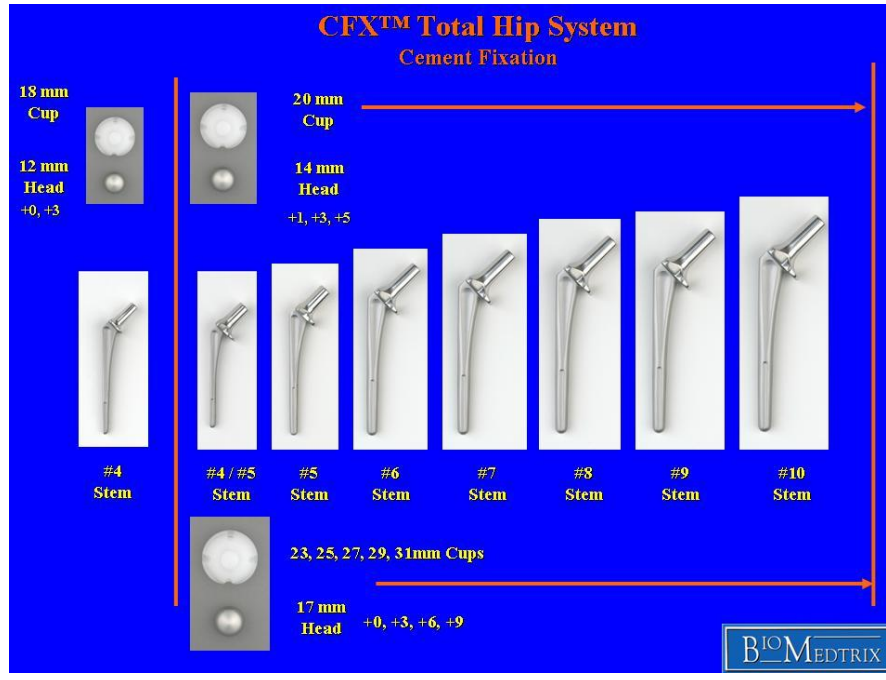
There is a learning curve for THR surgery like most complex surgical procedures. Once the procedure is mastered, it is extremely rewarding to observe client and patient satisfaction. However, complications can occur and the surgeon must be prepared to deal with them, or the surgeon should not risk performing the procedure in the first place.

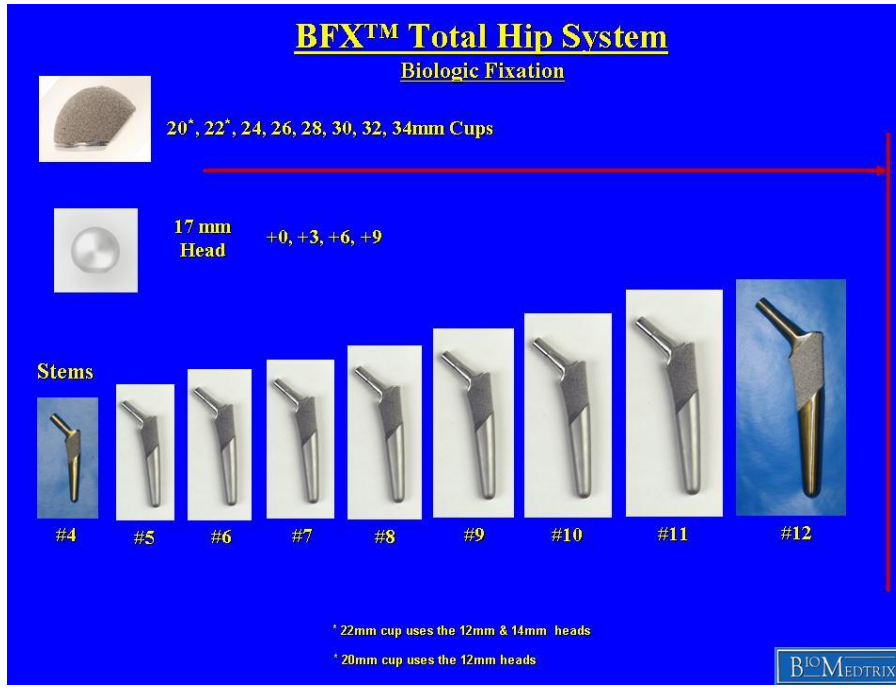
Versatility

The BioMedtrix cemented system (CFX) and biological fixation system (BFX) is modular. The femoral head sizes are interchangeable so a hybrid system can be implanted. The CFX system includes 7 femoral stems, 6 acetabular components, and 4 femoral head/neck lengths. The CFX Mini system offers 2 femoral stems, 1 acetabular cup, and 3 femoral head/neck lengths. The CFX Micro system offers 2 stems, 3 cups, and 2 head/neck lengths – both of which fit all 3 cup sizes. The CFX Nano system offers 1 stem, 1 cup, and 3 head/neck lengths and is used in animals as small as 4.5 pounds. The BFX system includes 7 femoral stems, 6 acetabular components, and 4 femoral head/neck lengths. With the wide variety of sizes available, the combined systems are extremely versatile for dogs (and cats) ranging in size from 2.5-80 kg or more. There are no apparent size restrictions within this range based on experience with over 100 breeds and indications including osteoarthritis, hip luxation, capital epiphyseal fracture, malunion, and revisions. As with fracture repair, the best prepared THR surgeon is the one capable of adaptation to multiple scenarios / patient needs – especially during unexpected intra-operative events.

Cemented and cementless system similarities

The CFX and BFX techniques have more similarities than differences. Advancing up to the cementless system learning curve is much easier if the surgeon is experienced with the cemented system. Preoperative care, preparation, approach, and exposure of the joint are the same. Templating to determine implant size can be done digitally or with acetate templates overlaid on radiographs. Either a positioning board or a bean bag is acceptable, but one or the other should be used to keep the patient positioning stable intraoperatively. The same anatomical references are used, and the femoral neck cut is at the same location for all sizes. The trial reduction, femoral neck length selection, final reduction, evaluation of joint stability, closure, and aftercare are the same for cemented and cementless prostheses.





Decision making between a cemented or cementless prosthesis

How is the decision made to implant a cemented or cementless THR prosthesis? The author's preference is the cementless (press fit) prosthesis. However, the best scenario is to be prepared to do either. If the primary choice is to use the BFX system, the surgeon must be prepared to default to the CFX system if technical difficulties arise (discussed later). The converse is rare that the surgeon would choose the CFX system and default to BFX implants. Therefore, if the cement-preferring surgeon has no intention of adding the cementless prosthesis to the repertoire, there are no decisions to be made. However, there are advantages of the cementless prosthesis that even the cement-preferring surgeon should consider. One approach that works well is to have a universal system, use the cementless system as the primary system, and use the cemented system as a trustworthy backup – including implanting a hybrid cemented/cementless prosthesis if needed.

What are some reasons why the surgeon would preference the cementless system? Bone cement is a variable in the cemented system that must be relied upon for the rest of the dog's life. With a high percentage (>35%) of dogs less than 2 years old receiving THRs, this variable must be a considered. The cementless procedure demands more precision which results in reproducible precise implant positioning. Even though more precision is required, the over-all procedure time is decreased by eliminating cement preparation, application, and curing time. Concerns about cement mantle pressurization, thickness, viscosity, porosity, antibiotic elution, dough versus liquid phase, intrusion, cure rate, long term strength, implant interface de-bonding, and eventual wear debris are eliminated by the cementless system. Also, there is no need for a medullary canal cement plug or a stem tip centralizer with the cementless system.

Cement is eliminated as a variable for life that could contribute to failure. Although the incidence is low, in the event of infection with cement present, permanent resolution (without explanation) is rare due to inability to deliver antimicrobials into porous avascular cement harboring organisms. Infection rates with cementless implants should be lower due to decreased surgical time, elimination of cement handling and exposure time to the OR environment, and the potential harboring of organisms in cement. Explantation, or revision to a cemented prosthesis, due to infection requires removal of all cement – which is not an easy task. Polyethylene and cement wear debris are possible causes of aseptic loosening. Concern about cement wear debris is eliminated when using the cementless system.

Power reaming is used on the acetabular bed preparation with both systems. Initial judicious power reaming can also be used on the cementless femoral bed preparation. Final cementless femoral preparation must be completed using broaches. When power is used in bed preparation, (acetabular and femoral) the reamer must be directed precisely in the eventual direction and orientation of the seated implant. Small tolerances within tenths of a millimeter in bed preparations can be achieved to secure press-fit implants short term. Bone ingrowth into a porous surface is a reliable method to secure implants for the long term.

When would the surgeon (who is capable of using both systems) use the cemented prosthesis instead being cementless exclusively? Currently, only a cemented prosthesis is available when using the CFX Miniature, Micro, and Nano systems so there is no option. Excluding cases where cementless implants are not available, over 90% of THR cases can be cementless.

Specific scenarios arise that make decisions difficult. Lack of dorsal acetabular rim (DAR) bone stock due to severe DAR wear from chronic subluxation, or a hypoplastic acetabulum secondary to congenital luxation, can result in lack of bone coverage of the dorsal aspect of the acetabular component. Three millimeters of exposed beads is generally safe in an otherwise well positioned well seated cementless cup. Three to five millimeters of beads left exposed is an increased risk of cup luxation, and leaving more than 5 mm is inadvisable. Similar guidelines of dorsal cup exposure apply to the cemented cup when augmentation should be considered. Augmentation with bone grafts is not uniformly successful and lack of bone coverage over an all-polyethylene cup can lead to eventual deformation failure and head luxation. With either system, the cup can be downsized to get better dorsal coverage. In addition, with the cementless system, iatrogenic protrusio into the medial acetabular wall is sometimes an acceptable alternative to achieving dorsal cup coverage.

The femoral neck becomes sclerotic in some patients which makes femoral bed preparation more difficult. When the bone is dense, and often concurrently more brittle, fissures are more likely to develop during broaching. Judicious tapered femoral power reaming staying 2 sizes smaller than the implant size makes bed preparation easier and minimizes the risk of fissure fractures. If fissures develop, they must be stabilized with full cerclage (preferably double-loop) wires 1 cm apart and extending at least 1 cm beyond the distal extent of the fissure(s). In most instances, it is advisable to cement the femoral stem, instead of proceeding with a cementless stem, when fissures are present.

Some dogs, particularly some German Shepherds, have extraordinarily large spaces in the trabecular bone with unusually large and cylindrical femoral canal inside diameters. Caution must be exercised to avoid femoral stem subsidence in these patients. Precautions that help prevent subsidence include making a high femoral neck cut leaving more calcar cortical bone for an upsized femoral stem to rest near. This maneuver will minimize the subsidence risk, but it can also make implant reduction extremely difficult – especially when preoperative coxofemoral subluxation is present. A good option to resolve this problem of cylindrical canals is to make the cut in the standard location and cement a collared prosthesis that rests on calcar cortical bone.

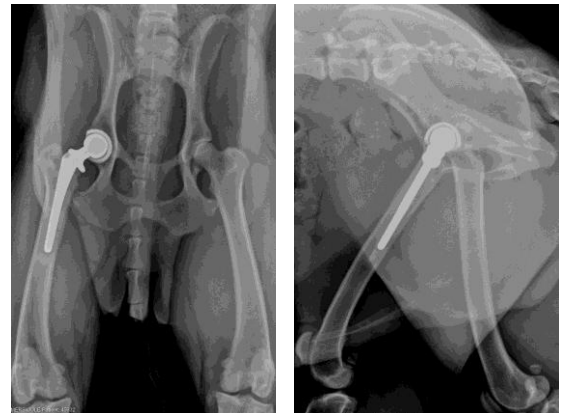


Figure 1. Unilateral hybrid THR with a BFX cup and a CFX stem in a German Shepherd

Rare technical errors, such as over-reaming, can result in improper cementless acetabular bed preparation. In these instances, the acetabular component is not stable so there is risk of cup displacement. An option to resolve this problem is to upsize the acetabular component. Upsizing is not always possible due to anatomical limitations. Rarely, an acetabular fracture will occur. These typically involve the caudal pole. If a fracture occurs, the acetabular component will not be stable. In both instances, cementing the implant is advisable. On the femoral side, over-reaming leaves the stem prone to subsidence due to a poor bone-implant interface. If the femoral stem drives too easy and too far distal during insertion, the surgeon should consider removal and either upsizing the cementless stem or cementing a CFX stem.

If some of the difficult cases are cemented, why not just cement all cases? The answer lies in the advantages of the cementless system discussed above.

Conclusion

In the short term, adopting a cemented system exclusively might be easier initially with less to learn. Adopting the cementless system exclusively could leave the surgeon vulnerable to unexpected intraoperative lack of necessary options to complete the procedure. In the long term, gaining expertise with both the cemented and cementless system (Universal System) will provide more versatility that should lead to better results with less risk and lower complication rates. The learning curve for the cementless system is relatively easy to climb for the experienced veterinary orthopedic surgeon who is on top of the learning curve with the cemented system.