Evaluation of the Femoral Stem Implant in Canine Total Hip Arthroplasty: A Cadaver Study

Hyung Sun Cho, Yonghwan Kwon, Young-Ung Kim, Jin-Su Kang, Kichang Lee, Namsoo Kim and Min Su Kim*

College of Veterinary Medicine, Chonbuk National University, Iksan 54596, Korea
*Department of Veterinary Clinical Science, College of Veterinary Medicine and Research Institute for Veterinary Science, Seoul National University, Seoul 08826, Korea

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Abstract: Total hip arthroplasty (THA) is a successful surgical treatment for both patients with chronic lameness and dogs who are nonresponsive to medical treatments, providing excellent joint function for returning dogs to the normal gait in 80% to 98% of hip dysplasia (HD) patients. The THA surgical implant system manufactured by BioMedtrix and Kyon are today widely accepted. When comparing the BioMedtrix biological fixation (BFX) system to the BioMedtrix cemented fixation (CFX) system, the many advantages of BFX, which include longer potential implant life, decreased risk of postoperative or later infection, and better implant stability, become evident. However, BFX implies a greater risk of femoral fracture during reaming and requires a more precise surgical technique to achieve good implant fit, given the press-fit nature of cementless THA. The purposes of this study are to both describe the mistakes and complications during stem implantation for beginner surgeons with both the BFX and the CFX systems and to document the initial result of 12 implantations in canine cadavers. Given the detailed evaluations of 3 specialists, who are Diplomate American College of Veterinary Surgeons (DACVS), only 3 of 11 stems were appropriately sized. Specifically, 6 stems were anteverted rather than being retroverted; further, although 7 stems were coaxial with the femoral long axis in the frontal plane, the other stems were in the varus at the frontal plane, with the proximal medial stem adjacent to the medial femoral cortex. Moderate angulation from the cranial to the caudal directions was found in 4 cases in the sagittal plane. Additionally, 1 case of femoral fissure and 1 case of perforated femoral cortex were reported. It is not easy for surgeons performing cementless THA for the first time to achieve a good result, even though they completed an educational course about it and given that catastrophic complications often occurred during early surgical clinical cases. Therefore, ex-vivo studies are sincerely required to get an expertise by rehearsing the preparation of the femoral envelop in isolated bones. Further studies should be conducted to achieve both highly accurate implant size and correct orientation during the preoperative planning. Additionally, surgeons’ learning curve should be examined in future investigations.

Key words: total hip arthroplasty, femoral stem, cementless biological fixation, evaluation, dog.

Introduction

Total hip arthroplasty (THA) is a successful surgical treatment for both patients with chronic lameness and dogs who are nonresponsive to medical treatments, providing excellent joint function for returning dogs to normal gait in 80% to 98% of hip dysplasia HD patients (22,24,27). THA is indicated for the treatment of hip joint painful conditions, including osteoarthritis (secondary to HD), irreparable fractures or femoral head and neck malunion, traumatic or chronic luxation of a dysplastic coxofemoral joint, failed femoral head and neck osteotomy, osteoarthritis (secondary to trauma), and femoral head avascular necrosis (2,9,19). However, THA has been usually indicated for medium-to-large size skeletally mature or near-mature dogs, considering the higher rate of inadequate implant fixation and complications reported in immature dogs with an open growth plate. Contraindications for THA include concurrent systemic health issues, concurrent neurological disorders, pelvic limbs orthopedic or recurrent infectious disease, or any combination of these disorders (15). THA should be performed at the late-stage of patients’life, when their medical treatment is no longer effective, given the longer duration of implantation and the greater risk of THA complications. In fact, THA surgery can be delayed until the medical treatments are no longer adequately effective and/or the clinical signs worsen. Additionally, surgery can be delayed when pain management combined with the achievement of an ideal body condition score (4 or 5 out of 9) are observed, also considering that exercise relieves the clinical signs (20,21). Conversely, THA surgery should be recommended when patients present chronic hip pain, or when both the patient and the disease are mature, as this would result in chronic hip dysplasia leading to severe morphological changes. These morphological changes, such as luxation, acetabular hypoplasia, dorsal acetabular rim wear, lateral drift of the proximal medial femoral cortex, medicalization of the greater...
trochanter, sclerosis of the proximal aspect of the femoral medullary canal, narrowing of the femoral isthmus, lateralization of the proximal aspect of the femur, and muscle atrophy (including contracture of the hip musculature muscles resulting from hip luxation), make surgery more technically challenging (13).

The THA surgical implant system manufactured by the Universal Total Hip (i.e., BioMedtrix), the Zurich Cementless Total Hip (i.e., Kyon), and the Micro Total Hip (i.e., BioMedtrix) are widely accepted. Furthermore, both the BioMedtrix press-fit cementless biological fixation (BFX) system (BioMedtrix, Boonton, NJ) and the BioMedtrix cemented total hip arthroplasty (CFX) were combined into the Total Hip system, which represents common instrument set and a regular surgical technique. This system has a general principle, regardless of whether a BFX cementless or a CFX cemented system is used, offering an advantage to surgeons who are provided with both a consistent technique and size compatibility. In fact, when a CFX cemented implant is desired, the procedure is modified at the completion of the BFX procedure and a switch from a cementless to a cemented hip occurs with minimal revision (1 mm smaller than BFX preparation). The Zurich Cementless Total Hip (Kyon, Zurich, Switzerland) provides more stability by adding screws in both the center of the acetabular component and the intertrochanteric area of the femoral component. Initially, THA was limited to large (>20 kg) and giant-breed dogs only. However, given that the Micro Total Hip share their design with the universal CFX system, it is possible to perform THA in dogs weighting less than 12 kg as well as in small dogs (2.5 kg) and cats. Although the Zurich Cementless Total Hip system reportedly showed lower postoperative subsidence than the BFX system, the Zurich system has a 17% higher rate of overall complication and lucency at the cup-bone interface is still reported (11).

When comparing the BFX system to the CFX system, the many advantages of BFX, which include longer potential implant life, decreased risk of postoperative or later infection, and better implant stability, become evident. However, BFX implies a greater risk of femoral fracture during reaming and requires a more precise surgical technique to achieve good implant fit, given the press-fit nature of cementless THA. Considering the nature of BFX, complications related to the femoral stems result to be likely, although the acetabular implants survival was shown to be reliable (6,12). In fact, complications related to the femoral component, such as femoral fissure formation, inappropriate stem position and subsidence are more commonly reported. Nevertheless, the difficulties and errors occurring during stem implantation in novice surgeons who first-time performance THA may be underestimated and unreported. Therefore, the purposes of this study are to both describe the errors and complications arising during stem implantation for beginner surgeons using both the BFX CFX systems and to document the initial result of 12 implantations.

Materials and Methods

Cadaver preparation

Six canine German Shepherds dogs (~20 kg) were euthanized for reasons unrelated to this investigation and recruited in this study if meeting the following inclusion criteria; (1) they were free of orthopedic disease; (2) absence of abnormal acetabulum or osteoarthritis was found; and (3) neurologic diseases were not present. Furthermore, both a cranio-caudal radiographic view of the affected femur and an open-leg lateral radiographic view of the femur were obtained for each limb to determine the appropriate stem size. The same radiographic protocol was followed for the postoperative radiographic examination. Cadavers were stored at −14°C and were left at room temperature (approximately 25°C) for 12 hours before surgery. The present study was performed in accordance with the guidelines set by the Ethics Committee for Experimental Animals of the Chonbuk National University (CBNU-2017-00224).

Preoperative radiographic assessment (Fig 1)

Both a digital radiography and magnetic bars were used in this study. The cranio-caudal radiographic view of the femur of the affected limb was obtained with the beam centered parallel to the femur, which provides an accurate and reproducible representation. Furthermore, an open-leg radiographic view of the femur was conducted on the dog, who was positioned in the lateral recumbency with the affected limb downward.
downward. After contralateral limb abduction and flexion, both the groin area and the proximal aspect of the affected limb were examined. This view delivered an oblique view of the acetabulum and a sight of the proximal aspect of the femur, without the superimposition of the opposite femur. Radiographs of each limb were repeated until the precise projections required were obtained. The same radiographic protocol was followed for the postoperative radiographic examination.

Implant selection and preoperative preparation
Successively to the determination of the magnification factor, the appropriate templates were superimposed over the femur radiograph in both the craniocaudal and lateral views to identify the appropriate femoral implant size. The key indicators for the selection of the stem size were stem fit and fill in the femoral canal at the appropriate level. While establishing the stem size for a BFX system, the largest stem which filled the confines of the endosteal margins of both the metaphysis and diaphysis was chosen. Additionally, the largest CFX stem which allowed space for an adequate cement mantle in the medullary canal of the femoral diaphysis was selected. However, although templating should be performed accurately, the final implant size selection is determined during surgery. Subsequently to their hair removal, dogs were positioned superimposed in the sagittal plane and secured through a positioning device.

Surgical procedure
The surgical procedure chosen for the implantation of the total hip replacement followed the hip joint modified cranial-lateral approach. Specifically, the insertion tendon of the deep gluteal muscle was transected through a L-shaped tenotomy, indicating that the proximal one-third to one-half of the tendon remained intact. Furthermore, T-shaped capsulotomy was performed. When an intact femoral head ligament was present, it was transected with a sharp Hatt spoon or other narrow sharp instruments, such as the disarticulator, that entered the hip joint space (6). Subsequently, the femur was rotated externally (by 90 degrees) to expose the femoral head and neck, which were then excised after putting the neck resection guide on the central axis of the femur (Fig 2A). The femoral neck resection was made parallel to the neck cutting guide when the guide was properly aligned. Moreover, osteotomies were made with an oscillating saw (Fig 2B).

Thereafter, the femur was rotated externally (by 90 degrees) and the aligned cranial aspect of the patella resulted parallel to the surgical table. The proximal femur was elevated via a Hohmann retractor to expose the femoral canal. Firstly, the pilot hole was created by using a 3.2 mm intramedullary pin with power drills (Fig 3A). Once the pilot hole was made, the remaining femoral neck was removed by rongeurs and the power reamer was driven into the femoral canal at the central axis of the femur. Successively, the sequential broaching was made to select the appropriate size and alignment (Fig 3B). After the preparation of the femoral canal, the BFX stem was inserted into the femoral canal and impacted by hand. The BFX stem drove into the femoral canal with the femoral component impactor and malleted until the “shoulder” of the femoral stem reached a position 2-3 mm below
the canal and the CFX stem was impacted until the collar of stem reached both the cranial and the medial cortex. Finally, the stem was secured while the excess cements were removed from the surrounding joint and tissues.

Trial heads were used to ensure the reliability of the joint reduction tension. Furthermore, trial reduction was performed to determine the correct alignment with an acetabular cup, correct neck length, and joint tension, while confirming the motion range. Once the reduction was satisfied, the head was placed onto the stem using the head impactor and mallet (Fig 4B). A cotton gauze was placed between the head impactor and the femoral head to prevent scratching of the implant surface.

The acetabulum and the femoral head implant were reduced and the motion range was confirmed again. The joint area was lavaged copiously with a sterile saline to remove the remnant tissues and cements, which was followed by the closure of the tissues in a standardized way.

**Postoperative radiographic assessment**

Postoperative radiographs, using both digital and computed tomography (CT), were repeatedly conducted immediately after the surgery until the precise projections were obtained, following the same preoperative radiographic protocol. The selection and the application of the correct implant were evaluated for both the BFX and the CFX system. Subsequently, adequate BFX stem size and alignment with the femur axis was confirmed on the lateral and open-leg lateral

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**Fig 4.** Photographs of the THA surgical procedure. (A) The BFX stem drove into the femoral canal with both the femoral component impactor and the mallet, until the “shoulder” of the femoral stem reached 2-3 mm lower than the most proximal aspect of the edge of the femoral neck with the greater trochanter. (B) Once the reduction was satisfied; the head is placed onto the stem using the head impactor and the mallet.

**Fig 5.** Ventrodorsal and lateral radiographs of the pelvis (A and B) and craniocaudal and open-leg lateral radiographs of the femur (C and D) after the BFX stem implantation. Correct implant selection and application were evaluated in the BFX system. Adequate BFX stem size and alignment with the femur axis were evaluated on the lateral and open-leg lateral radiographic views.

**Fig 6.** Ventrodorsal and lateral radiographs of the pelvis (A and B) and craniocaudal and open-leg lateral radiographs of the femur (C and D) after the CFX cup and stem implantation. Correct implant selection and application were evaluated in the CFX system.
Radiographic views. In concordance, the CFX femoral implantation followed the same assessment procedures of the BFX femoral implant, while the cement mantle was also measured. The evaluation was performed by 3 specialists, who are DACVS. Additionally, CT and 3D-implementation was also used to assess the implant and application of both BFX and CFX. Stem size, stem level, and stem position were evaluated using numerical rating scales, comprised of 4 grades: 0 = very poor; 1 = poor; 2 = acceptable; 3 = good. This analysis was performed after stem implantation (Fig 5-10).

**Results**

**Intraoperative findings**

Pairs of femur from 6 canine German Shepherds dogs, who did not have any orthopedic disease, such as hip dysplasia or osteoarthritis, were used in this study. Of the 12 cases, 10 were performed with the BFX system and 2 with the CFX system. Issues while approaching either the hip joint or the femoral head for osteotomy were not reported; also exposure...

![Fig 7. Volume-rendered 3D CT images of both the BFX (A) and CFX (B) cup and stem implantation. CFX 3D implementation was impeded by cement.](image)

![Fig 8. Ventrodorsal and lateral radiographs of the pelvis (A and B) and craniocaudal and open-leg lateral radiographs of the femur (C and D) for the evaluation of the complications associated with femoral stem implantation. Femoral fractures occur more often in the BFX THA than the CFX THA during surgery. The fractures are usually fissure fractures which occur at either the calcar or the intertrochanteric area during reaming of the femoral canal or placement of the femoral stem.](image)

![Fig 9. Ventrodorsal and lateral radiographs of the pelvis (A and B) and craniocaudal and open-leg lateral radiographs of the femur (C and D) for the evaluation of the complications associated with femoral stem implantation. One of the cases had a perforation at the proximal femur. High incidence of fracture is probably influenced by technical failure, which includes over-reaming of the femoral canal or improper ‘angle of attack’ during femoral reaming.](image)
was successful. Furthermore, in the case of stem implantation, femur preparation was positive, although the direction of the pin, reamer, and broacher was not appropriate. In contrast, trial reductions, head impaction and surgical field closure were completed without any difficulties. Finally, 3 implantations had catastrophic complications, including perforation of either the acetabulum or the femur, and femur fissure fracture (Table 1).

**BFX and CFX stem implantations (n = 11)**

Only 3 of 11 stem implantations were appropriately sized; in contrast, femoral osteotomy levels were correct in all cases. The insertion depth was satisfactory, with the shoulder of the stem positioned at the level of the proximal third of the medial border of the greater trochanter, except for one case. Furthermore, 6 stems were anteverted rather than being retroverted. Although 7 stems were coaxial with the femoral long axis in the frontal plane, the other stems were in the varus of the frontal plane, with the proximal medial stem adjacent to the medial femoral cortex. Additionally, a moderate angulation from the cranial to the caudal direction was observed in 4 cases in the sagittal plane. Finally, a case of femoral fissure and a case of perforated femoral cortex were reported.

**Discussion**

Total hip arthroplasty (THA) was proved to be a successful method for treating coxofemoral joint disease in mature large-sized dogs (8,22). However, various complications of canine THA were reported, including infection, aseptic loosening of implants, coxofemoral luxation, implant failure, femoral fracture, acetabular fractures, sciatic neuropaxia, neoplasia, acetabular cup displacement, and pulmonary embolism (1,2,12,24). Furthermore, complications related to the BFX system were described, such as continued lameness, subsidence of the femoral stem, lucency at the acetabular cup-bone interface, joint luxation, fissure fracture, bone infarction, and acetabular displacement (10,12,27). Lastly, complications associated with the CFX system include hip joint luxation, infection, and aseptic loosening (2).

A previous study indicated the short-term outcome of the BFX THA (12) and described that 25% of the patients reported minor complications requiring no additional surgery, whereas 11% of the patients had major complications demanding surgical revision. Specifically, minor complications refer to stem subsidence and stem rotation. Subsidence is the primary problem related to BFX THA and suggests distal displacement of the femoral stem within its canal. Further, stem size and position are the most important factors associated with subsidence. In a previous report, stem placement showing a greater than 85% canal fill at either the middle or distal point had less subsidence rate (28). Another study suggested that undersized stems in the neutral angulation present a greater subsidence rate than large stems placed in the neutral angulation or undersized stems located in the varus angulation (25). Subsidence may cause luxation and potential complications considering that the bone fails to impact the stem, leading to proximal and distal stem movement during weight bearing. Therefore, appropriate selection of the stem size and reaming and broaching of most of the bone in the proximal femur is crucial to obtain a good implant-bone contact and prevent subsidence. If severe subsidence occurs, either fresh reaming and placement of CFX or femoral head and neck osteotomy is used to treat such complications. In contrast, the major complications refer to luxation and femoral fractures. Specifically, luxation is the most common problem associated with the short-term operation outcome (12). While inappropriate implant placement is the cause of intraoperative or immediate luxation, long-term luxation is often related to trauma in BFX THA. Luxation results from subsidence and rotation, impingement, and lack of tissue tension (2). Proper placement of the acetabular cup, the surgical technique, and intra-operative implant selection are the key to prevent luxation. Several studies suggested the existing assessment methods to provide appropriate placement of the cup, neck length, and femoral orientation (4). Patients with a luxation are currently treated by close and open reductions, triple pelvic osteotomy, iliopsoas tendons, and via increasing the femoral neck length (12). Importantly, femoral fractures occur more often in BFX THA than CFX.

### Table 1.

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THA during the surgery. They are usually fissure fractures, which occur at either the calcare or intertrochanteric areas during femoral canal reaming or femoral stem placement. Additionally, a previous investigation indicated both osteopathy and iatrogenic fissures to represent risk factors of fractures (3). However, the high incidence of fractures is likely influenced by surgeon technical errors, including over-reaming of the femoral canal or improper ‘angle of attack’ during the femoral reaming (14). Although minor fissure fractures occurring during the surgery may be stabilized by cerclage wire, catastrophic fractures may be treated with bone plates. Besides, sciatic neurapraxia, lack or loss of bone ingrowth, and infection were also identified. Sciatic neurapraxia was previously thought to be an uncommon complication in THA patients; however, a study reported that 1.9% of patients had sciatic neurapraxia. Sciatic neurapraxia is defined as the failure of nerve conduction, as a result of myelin disruption, which leads to structural changes and partial loss of axonal integrity and iatrogenic sciatic nerve injury should be avoided during THA surgery. Furthermore, the lack or loss of bone ingrowth in patients was repaired by the placement of larger BFX cups. Aseptic loosening was a common complication of CFX THA described in several clinical case studies (22). It occurred more often at the junction of cement-bone interface rather than the cement-implant interface. Specifically, the presence of metal, plastic, or remnant cement responded to the surrounding bone and induced bone resorption, leading to aseptic loosening (7). Additionally, aseptic loosening occurred by the presence of inappropriate biomechanical forces, which cause both the cracking of the cement and the degradation of the cement-implant interface (7). Recommendations for the treatment of aseptic loosening include removal of the total hip arthroplasty and linear osteotomy in the lateral wall followed by the shifting of both the cement and the stem proximally (5). Removal of THA is performed by either removing the entire lateral cortex over the implant and subsequently removing both the cement and stem, or by removing both the cement and stem by applying a proximally-directed force from the distal end. Moreover, infections happened more frequently in cemented rather than cementless THA.

Incision dehiscence or discharge and inflammation at the surgical field seemed to induce infection. Given that sole antibiotic therapy is unsuccessful, implants removal, including cement removal, is recommended for the appropriate treatment of infection. Several investigations reported the predisposing factors to luxation, such as cup orientation, body size and conformation, and short femoral neck (23). Pulmonary embolism is a more likely complication of cemented THA, which represents a potential cause of death in dogs (17). Although, the cause of embolism is not yet been identified clearly, it occurs during both femoral stem and cement insertion with intramedullary pressure and femoral medullary contents (16). During femoral stem impaction, cement placement into the cancellous bone could cause embolization of trapped air and dislodged echogenic particle (17). Both copious, strict lavage of the bone-cement interface with high-volume and high-pressure for the removal of embolic particles and the usage of the cement-free femoral component are valid options for the prevention of pulmonary embolism prophylactically (18). Although most of the THA patients recovered from the pulmonary embolism spontaneously, surgeons should be aware of the possibility of pulmonary embolism during THA surgery.

In the present study, femoral osteotomy levels and depth of the insertion were appropriate in most cases. However, correct stem size and femoral stem positioning were not realized in almost every case. It is critical to get highly accurate stem sizing and positioning for a successful outcome and to avoid the risk of complications. In the current study, an appropriate stem size was reported in only 3 cases. Subsidence has been a primary concern related to cementless BFX THA and occurred more frequently with undersized stems (26). Although a mild subsidence (1-3 mm) is commonly expected, it does not usually result in clinical signs. However, subsidence > 3 mm may lead to decreased stem stability, which may in turn predispose to major complications, including hip joint luxation and femoral fracture (18). In future studies, given that both the fit and the fill of the stem at the appropriate level in the canal is the crucial factor for the selection of the stem size, it would be better to select the largest implant which fills the confines of the endosteal margins of the metaphysis and diaphysis during the planning with an accurate templating system. Furthermore, despite many previous studies used a percent canal fill to reflect stem sizing (26,29), a recent study suggested this measurement not to represent an appropriate method to assess correct stem size and it recommended using the orthopedic templating system instead (29). Therefore, selecting a stem size through orthopedic templates would be better to evaluate the stem size in future studies rather than using a percentage of the canal fill.

In the most of present cases, stem positioning was almost inappropriate, leading to potential complications in a clinical case. According to a study which documented the effect of malalignment with cementless femoral stems, stems placed over 5 degrees in the varus position showed a 50% more strain than those in the neutral position, resulting in an increased complication rate of the femoral fissure (25). While stems impacted in a neutral position were related to an even strain distribution, stems impacted in a varus position caused medial positioning of the proximal stem, which increases pressure on the cranioexternal aspect of the proximal femur and represents the most common area for fissure fracture (25). Therefore, the varus positioning of the stem will consistently deplete the cancellous bone at the medial margin of the osteotomy and increase the risk of femoral fissure. Additionally, a recent study suggested that the stem appropriate positioning and avoiding a varus angulation may prevent the intraoperative fissure formation (10). A preoperative cranio-caudal femoral radiograph was conducted to determine both the distance to the medial border of the greater trochanter, which used to be a useful intraoperative landmark, and the appropriate selection of the implant angulation are crucial factors to achieve a good alignment. The misalignment in the sagittal plane will also bring the stem into contact with the cortical bone proximally. This is given that the stem position
could be a consequence of both inadequate elevation of the proximal femur and depression of the stifle during femoral preparation. Strict preoperative planning of stem placement and surgery followed by guidelines must be performed to minimize the risk of complications.

Femoral fracture occurred in 2 cases and one of them had a perforation at the proximal femur. Fracture often was present at the end of the BFX implant due to the concentration of forces resulted from differences in the elastic modulus between implant, cement, and bone. The proximal end of the femur, where both the BFX and the CFX stem are, loses elasticity due to their presence. Forces and pressure concentrated at the site of the implant increase the risk of fracture. Often, although the fissure fracture occurs during the reaming of the femoral canal, it often remains undetected. In fact, in the presence of a fissure fracture, it becomes fragile when loading, rotational, or torque forces are applied, leading to a propagation of the fissure and a displaced fracture (3). As mentioned above, the high incidence of the fracture is probably influenced by surgeons’ technical failure, which includes over-reaming of the femoral canal or improper ‘angle of attack’ during femoral reaming (14). To keep the incidence low in future studies, care should be taken in both reserving some time for preoperative planning and in carefully performing surgery. During the preoperative planning, the distance from the great trochanter and the angle along the axis should be evaluated strictly. In contrast, during the surgery, the reaming process should be performed very carefully, slowly and in low intensity. Additionally, the reamer should always remain along the axis.

Only 1 case of CFX THA was performed in this study with limitation and seemed a technically well done cemented THA. It was difficult to use cement in cadavers, however, we would expect the femoral cement mantle to be better in the clinical cases. During stem insertion, stem size #8 was replaced by the #7. In the clinical cases, it would be difficult to withdraw a stem because it was too large and then reinsert a more appropriately-sized stem without compromising the cement mantle.

The conclusion which can be drawn from this study on THR surgery performed by beginner surgeons are these: for future clinical cases make appropriate stem size, avoid stem angulation in the coronal and sagittal planes, which are points of emphasis. Care should be taken to ensure that the stem anteversion matched cup retroversion to permit the best motion range without impingement. The combined technical errors of stem retroversion and cup anteversion would contribute to a freedom of motion range in the hip with regards to internal/external rotation. For both successful outcomes and avoiding catastrophic complications, spending some time in planning is crucial to achieve a highly accurate implant size and positioning. Furthermore, surgery should be taken by surgical guidelines strictly. Ex-vivo studies are essential to minimize the surgical failures and complications in THA in dogs, although THA represents a successful surgical treatment for disabling diseases of the coxofemoral joint, providing the patients with excellent hip joint function. Moreover, many complications associated with cementless THA were reported. As mentioned in this study, many complications can be prevented if the surgeon has a thorough understanding of the surgical guidelines and technical knowledge of both the implant and the instrumentation. Accurate preoperative planning and correct orientation of the acetabular and femoral components are crucial factors to accomplish a stable articulation without impingement. It is not easy for surgeons who performed first-time cementless THA to achieve a good result, even though they followed an educational course and catastrophic complications often occurred during the early-time surgery in the clinical cases. Therefore, further ex-vivo studies are required to get an expertise by rehearsing the preparation of the femoral envelop repeatedly in isolated bones. Additionally, further studies investigating a highly accurate implant size and the correct orientation during preoperative planning are needed.

References


