Abstract

Objective: To assess the variables associated with complications of total hip replacement (THR) and report owner-assessed outcomes.

Methods: Entries into the British Veterinary Orthopaedic Association-Canine Hip Registry (BVOA-CHR) between September 2011 and December 2012 were reviewed separately and in conjunction with previous data (January 2010 – August 2011). An outcomes assessment questionnaire was used to collect data from owners.

Results: Incidence of surgeon and owner reported complications were 8.2% and 4.3% respectively. THR using the Biomedtrix BFX® cup/stem prosthesis had a greater incidence of complications compared to THR using the Biomedtrix CFX® cup/stem prosthesis (p=0.002); complications were 4.48 times more likely when using the Biomedtrix BFX® cup/stem prosthesis versus the Biomedtrix CFX® cup/stem prosthesis. THR using the Biomedtrix BFX® cup/stem prosthesis had a higher incidence of complications compared to THR using a hybrid prosthesis (Biomedtrix BFX® cup/CFX® stem, Biomedtrix CFX® cup/BFX® stem) (p=0.046); complications were 2.85 times more likely when using the Biomedtrix BFX® cup/stem prosthesis versus a hybrid prosthesis. In 95% of cases, owner satisfaction with the outcome of THR was 'very good' or 'good'.

Conclusions: Complication rates from the BVOA-CHR are similar to previous studies. The data suggest that prosthesis type is associated with complication rate, with BioMedtrix BFX® (circa 2012) having a high short-term complication rate.

Introduction

The BVOA-CHR (British Veterinary Orthopaedic Association-Canine Hip Registry http//:www.caninehipreplacement.org), hosted at the University of Liverpool Veterinary School, is an online database established in January 2010 (Forster and others 2012). The aim of the registry is to collate data from multiple veterinary referral clinics regarding techniques and complications associated with canine total hip replacement (THR) through surgeon-based registration of cases, informed owner consent, and prospective outcomes assessment using a client-administered online clinical metrology instrument. The BVOA-CHR offers an ongoing follow-up on all cases submitted, whereby surgeons are encouraged to document complications as and when necessary, months or even years after surgery. A previous report by Forster and others (2012) describes 170 cases of THR. Continued submission of complications associated with these cases can occur and therefore enables long-term complications of THR to be reported.

THR is a successful surgical treatment for debilitating conditions of the coxofemoral joint, providing high success and low complication rates. Success rates for either cemented or cementless THR have been reported at 80% to 98% based on both clinical and radiographic evaluation of pain status and functionality, and owner assessment (Olmstead and others 1983, Olmstead 1987, DeYoung and others 1992, DeYoung and others 1993, Massat and Vasseur 1994, Olmstead 1995, Marcellin-Little and others 1999, Skurla and others 2000). Previous results obtained from the BVOA-CHR revealed that in 94% of cases owners described their satisfaction with the outcome of THR as “very good” or “good” (Forster and others, 2012).

Commercial systems are available for both cemented and cementless total hip replacement components. Currently commonly used implants in the United Kingdom include the cemented fixation Biomedtrix CFX® cup/stem (BioMedtrix, LCC, Boonton, NJ) and cementless fixation Biomedtrix BFX® cup/stem (BioMedtrix, LCC, Boonton, NJ), Helica (Innoplant veterinary, Hannover, Germany) and Kyon (Kyon Pharma, Inc., Zurich, Switzerland). Cemented fixation relies on a mantle of polymethylmethacrylate bone cement acting as a sealant between the implant and the bone. The CFX® system provides a consistent fit regardless of femoral size and allows immediate prosthesis fixation.

Cementless systems rely upon osseointegration in order to achieve fixation. Cementless THR have reported similar complication rates to that of cemented prostheses (DeYoung 1992, DeYoung and others 1993, Guerrero and Montavon 2009). Using a combination of cemented femoral and cementless acetabular components has been described as an alternative to either entirely cemented or cementless implantation. (Minto and others 2011, Gemmill and others 2011).

Complication rates after THR usually range between 5 and 20% although different rates have been described owing to the wide variety of systems used in different populations (Olmstead 1995, Olmstead 1995, Edwards and others 1997, Guerrero and Montavon 2009, Gemmill and others 2011). Complications previously reported using data obtained from the BVOA-CHR included luxation, femoral fracture, minor wound dehiscence, wound sepsis, protrusio acetabuli, acetabular cup displacement, suspected pulmonary thromboembolism and death at end of surgery, femoral pain, femoral subsidence and sciatic paresis (Forster and others, 2012). Other major complications include aseptic loosening, septic loosening, femoral medullary infarction and patellar luxation. (Massat and Vasseur 1994, Marcellin-Little and others 1999, Ota and others 2005, Bergh and others 2006, Marsolais and others 2009).

While a handful of studies reporting each system individually and their success and complication rates are available, the case numbers remain relatively small. Using data obtained from the BVOA-CHR, our aims were (i) to identify any significant association or correlation between patient background variables (age, body weight, breed, and sex) and surgical variables (indication for surgery, prosthesis used), and the incidence of complications; and (ii) using the Liverpool Osteoarthritis in Dogs (LOAD) (Hercock and others 2009, Walton and others 2013) scores from an owner-assessed outcomes questionnaire, to report the owner-assessed outcome of THR.

Materials and Methods

The structure and workings of the BVOA-CHR have been previously described (Forster and others, 2012). Briefly, information on each THR was submitted on a Microsoft Sharepoint site. Complications were submitted separately and were cross-referenced to the original surgery by the registry

administrator. Complications were categorised as ‘catastrophic’, ‘major’ and ‘minor’ according to the definitions of Cook and others (2010). Participating surgeons signed a confidentiality disclosure agreement (CDA) with the University of Liverpool Veterinary School stating that the variables of “surgeon” or “clinic” would not be used in data analyses. Participating surgeons were encouraged to submit all operated cases to the BVOA-CHR.

Records of the BVOA-CHR database between September 2011 and December 2012 were exported to an Excel spreadsheet (Microsoft Excel 2011, Microsoft) and reviewed. A total of 140 THR cases were analysed with 136 cases meeting the inclusion criteria for the study; 4 cases were unavailable for the use because of inaccurate or missing data on the database. These cases were collated with 170 records of the BVOA-CHR database between January 2010 and August 2011 (Forster and others, 2012), resulting in a total of 306 cases.

Complications could also be submitted by the owner, via a questionnaire. The same online owner-administered outcomes assessment questionnaire was used as previously reported (Forster and others 2012); a questionnaire modified from the ‘Liverpool Osteoarthritis in Dogs’ (LOAD) clinical metrology instrument (Walton and others 2013). Briefly, the questionnaire was divided into four sections. Section A was composed of 10 questions and assessed information regarding the length of on-going mobility problems, medications received, and other concurrent medical history unrelated to hip dysplasia. Section B was composed of 13 questions and assessed activity and willingness to exercise before THR. Section C was composed of three questions and assessed whether unilateral or bilateral THR was carried out, overall owner satisfaction, and complications reported. Finally, section D was composed of 13 questions and assessed activity and willingness to exercise after THR. Questions and scoring were identical in sections B and D enabling a pre- and post-THR lameness score to be calculated. The complete questionnaire was sent to cases where the date of surgery was between September 2011 and December 2012 (Group One, < 16 month follow up), whereas a modified follow-up questionnaire containing only sections C and D was sent to cases where the date of surgery was prior to September 2011 (Group Two, 17 - 36 month follow up). For those cases without a contact email address, the questionnaire was sent via postal service.

Statistical Analysis

The dataset was reviewed and checked for coding of all variables. Descriptive statistics were calculated for each variable and data were analysed using software (SPSS Inc. SPSS Statistics for Mac, Version 20.0. Armonk, NY: IBM Corp). Statistical significance was set at $P<0.05$. Associations between each variable and the incidence of complications were assessed using logistic regression analysis. Univariable binomial logistic regression was used to calculate measures of strength of association for each variable with the presence of complications. A Mann Whitney U-test was performed using the SPSS statistical software package to assess the significance of total lameness scores before and after THR and between groups.

Results

One hundred and thirty six THR cases met the inclusion criteria and were reported by veterinarians via online submission (September 2011 – December 2012). These new reports were collated with those previously reported, resulting in a 306 cases (Forster and others 2012) (January 2010 – August 2011).

Cases were recorded by twenty-four veterinary surgeons from twenty small animal clinics within the United Kingdom. The average case contribution per surgeon was 12.75 cases (range; 1- 41 cases/surgeon). Dogs ranged from less than 1 year to 12 years of age (mean ± SD, 3.38 ± 2.86 years), with 39% of dogs being less than two years old, and weighing 4.00–72.00 kg (mean, 28.47kg ± 10.80 kg). There were 129 female (40 intact, 89 neutered) and 177 male dogs (110 intact, 67 neutered). The Labrador Retriever (n = 91), German Shepherd dog (n = 43), Crossbreed (n = 39), Border Collie (n = 27), Golden Retriever (n = 16), Rottweiler (n = 13), English Springer Spaniel (n = 11), West Highland White Terrier (n = 10) and Cocker Spaniel (n = 7) were the most frequently represented breeds. Indications for surgery included hip dysplasia and osteoarthritis (n = 268), recurrent luxation (13), avascular necrosis of the femoral head (8), Legg-Calvé-Perthes disease (7), fracture (7), and traumatic luxation (3). Surgical implants included BioMedtrix CFX cup/stem (n = 140), BioMedtrix hybrid (n = 74); using BioMedtrix BFX cup and CFX stem (n = 68) or BioMedtrix CFX cup and BFX stem (n = 6), BioMedtrix BFX cup/stem (n = 39), Helica (n = 34) and Kyon (n = 19). Thirty-nine dogs underwent

bilateral staged THR.

Complication Rate

The BVOA-CHR data collected since January 2010 (306 cases) was combined with information on the incidence of complication, treatment and outcome gained from owner completion of their questionnaire.

The incidence of surgeon-reported surgical complication was 8.2%. The incidence of owner-reported complications was 4.3%. Complications (comprising of those reported by owner and/or veterinary surgeon) included luxation (n = 11), femoral fracture (9; 7 postoperative cases, 2 intraoperative cases), problems associated with wound healing (9), aseptic loosening (6), acetabular fracture (2), sciatic paresis (1), femoral pain (1), femoral subsidence (1), protrusio acetabuli (1) and cardiac arrest (suspected pulmonary thromboembolism) (1) (Table 1.). Two catastrophic complications occurred; cardiac arrest in a case with hybrid fixation (BFX cup/CFX stem), and femoral fissure that led to euthanasia in a Kyon case (Table 2.). Three minor complications occurred which were all associated with the CFX cup/stem prosthesis. These included sciatic pain, femoral pain and protrusio acetabuli. The remaining complications (n=37) were classified as major, requiring additional surgical or medical treatment. Five cases of explantation were classified as major complications based on this classification system.

Eleven cases of luxation were reported (2 BFX cup/stem, 5 CFX cup/stem, 1 CFX cup/BFX stem, 2 Helica, 1 Kyon). Luxation was reported at 0 (n=2), 8, 10, 18, 57, 235, 300 and 302 days. In two cases the time of luxation was not specified. In one case the hip had luxated during postoperative radiography; excision of new bone formation, which was causing ventral impingement followed by reduction resulted in a successful outcome. Two cases resulted in explantation; in one of these cases the hip had reluxated on two occasions (302 days and 363 days). One case was managed with closed reduction and Ehmer sling application. The remaining cases were managed via open reduction with either the same sized implant or an increased femoral head/neck length.

Three cases of aseptic loosening were reported by the veterinary surgeon and three cases by the owner

(4 Helica, 2 BFX cup/stem). Veterinary surgeons reported aseptic loosening at 147, 202 and 418 days postoperatively, all of these occurred using the Helica prosthesis. Three cases of aseptic loosening were reported by the owner to have occurred in the first three months following surgery (2 BFX cup/stem, 1 Helica). Revision surgery was carried out in four cases and THR explantation in two cases.

Nine femoral fractures were reported (5 BFX cup/stem, 1 CFX cup/stem, 1 BFX cup/CFX stem, 2 Kyon); 7 cases of postoperative femoral fracture and 2 cases of intraoperative femoral fracture or fissure formation. On both occasions where the fracture occurred intraoperatively (1 CFX cup/stem, 1 BFX cup/stem), successful repair was carried out using cerclage wire alone, without explantation. Femoral fracture occurred 17 days after surgery using the Kyon prosthesis; the animal was euthanased. A further 6 cases of femoral fracture were reported, of which 5 (3 BFX cup/stem, 1 BFX cup/CFX stem, 1 Kyon) were treated successfully and 1 case (BFX cup/stem) required explantation. Femoral fracture occurred in 7 cases, which used a cementless femoral prosthesis (5 BFX cup/stem, 2 Kyon), and 2 cases using a cemented femoral prosthesis (1 CFX cup/stem, 1 BFX cup/CFX stem).

When accounting for all complications, ten cases that had complications were identified with the CFX cup/stem prosthesis (10/140, 7.1%), 10 with the BFX cup/stem prosthesis (10/39, 25.6%), 8 with a hybrid prosthesis (8/74, 10.8%), 6 with the Helica prosthesis (6/34, 17.6%) and 4 with the Kyon prosthesis (4/19, 21.1%) (Table 3). In some cases, more than one type of complication occurred (n=3, Table 1 and 2). However, statistical analysis was completed on the basis of whether the case had a complication, be that one or several (Table 3). No statistical significance was identified between weight, age, gender, breed nor indication for THR and the incidence of complications. A relationship between prosthesis and the occurrence of complications (inclusive of catastrophic, major and minor complications) was identified. THR using the BFX cup/stem prosthesis had a significantly different incidence of complications compared to THR using the CFX cup/stem prosthesis ($p=0.002$). A complication was 4.48 times more likely to occur when using the BFX cup/stem prosthesis versus the CFX cup/stem prosthesis. THR using the BFX cup/stem prosthesis had a significantly different incidence of complications compared to THR using a hybrid prosthesis ($p=0.046$). A complication was 2.85 times more likely to occur when using the BFX cup/stem prosthesis versus a hybrid prosthesis. Of the complications which occurred using hybrid prosthesis, 7/8 complications used a BFX cup/CFX stem

combination. Complications included fracture of the acetabulum (n=2), wound infection (n=3), cardiac arrest (n=1) and femoral fracture (n=1). One case of luxation occurred with the use of a CFX cup/BFX stem prosthesis. No significant difference in complication rate was found between any of the other prosthetic types.

Owner Assessment Questionnaire

Group One (136 cases, < 16 month follow up)

A total response rate of 55% was achieved for group one via the online owner assessment questionnaire. 11% dogs were reported as 'not at all disabled' by their lameness before THR. A total of 43% dogs were considered lame by owner assessment for 0-6 months before THR, whereas 25% were lame for 6-12 months, and 32% for more than 12 months before surgery. In the last month before surgery 59% of dogs were receiving 0-1 mile of exercise per day before THR, whereas 25% received 1-2 miles of exercise, and 16% received more than 2 miles of exercise. Of these, 34% received mainly off-lead exercise, whereas 66% received mainly on-lead exercise.

In 81% of cases, owners described their satisfaction with the outcome of THR as 'very good', 14% as 'good', 1% as 'fair' and 4% as 'poor'. No owners rated their satisfaction as 'very poor'. There was no significant difference in owner assessed lameness scores between those dogs that had undergone unilateral THR and those that had undergone bilateral THR (preoperatively; $p=0.30$, postoperatively; $p=0.61$). There was a statistically significant difference in owner assessed lameness scores before and after THR ($p<0.001$) with the mean LOAD score before and after THR being 22/52 and 6/52, respectively.

Group Two (170 cases, 17 - 36 month follow up)

85% of owners that had originally responded to the questionnaire within 24 months of surgery (1) also completed the follow-up questionnaire containing sections C and D only (<36 months following surgery). Three complications previously not reported by either the veterinary surgeon or the owner were

identified, aseptic loosening (within 3 months following surgery, n=2, BFX cup/stem prosthesis) and luxation (n=1, CFX cup/stem prosthesis). The time of luxation following surgery was not provided and contact with the owner to gain further information was unsuccessful.

In 88% of cases, owners described their satisfaction with the outcome of THR as 'very good', 6% as 'good', 5% as 'fair' and 1% as 'very poor'. No owners rated their satisfaction as 'poor'. Owner-assessed lameness scores reported <24 months after THR and scores reported approximately one year later (<36 months after THR) were significantly different ($p<0.01$) with the mean LOAD score within 24 months of THR being 5.6/52 and approximately one year later being 8.7/52. However, the score reported <36 months after THR was still significantly lower than that reported prior to surgery (preoperative score 18.7/52, $p<0.001$).

Discussion

In 95% of cases, owners of animals that had surgery <24 months previously, described their satisfaction with the outcome of THR as 'very good' or 'good'. In 94% of cases, owners of animals that had had surgery <36 months previously, described their satisfaction with the outcome of THR as 'very good' or 'good'. The questionnaire was based on LOAD; a validated owner-completed clinical metrology instrument that is recommended for the measurement of canine osteoarthritis, which has documented 'criterion validity' (correlation with force-platform data) (Walton and others 2013). The LOAD scores reported both <24 months and <36 months after THR were significantly lower than those reported prior to surgery ($p<0.001$). Seemingly, there is a high degree of owner satisfaction up to 36 months following THR. We appreciate that reliance on owner perception of lameness is not always reliable (Soderman 2000), and that owner interpretation of lameness or the term 'disabled' may differ from that of a veterinary surgeon. Interestingly, 11% of cases were reported as 'not disabled' by the owner prior to THR. The potential that these animals received surgery due to radiographic assessment alone and without overt clinical signs of lameness or pain exists. However, owners' opinion regarding the ability to ambulate is somewhat unreliable, especially when considering cases where bilateral pelvic limb lameness is present. Also, a large proportion of dogs are non-surgically managed via exercise restriction prior to surgery, and therefore interpretation of lameness by the owner can be difficult.

Dogs ranged from less than one year to 12 years of age (mean ± SD, 3.38 ± 2.86 years), with 39% of dogs being less than two years old. A substantial proportion of dogs undergoing THR are less than two years old. In our opinion, prospective monitoring of the performance of THRs is of great importance if we are to assess the longevity and efficacy of this intervention. Continued yearly reporting of the BVOA-CHR will provide information on the success of THR prostheses in such young dogs.

There was not a significant difference in owner-assessed lameness scores between those dogs that had undergone unilateral THR and those that had undergone bilateral THR (preoperatively; $p=0.30$, postoperatively; $p=0.61$). However, due to the majority of cases not requiring bilateral surgery (8, 10), the statistical power of this assessment was limited and data for the degree of lameness (LOAD score) between the first and subsequent surgeries was lacking.

Complication rates, gained from collating data from both the BVOA-CHR and owner assessment questionnaire, are similar to previously documented studies (Olmstead 1995, Edwards and others 1997, Guerrero and Montavon 2009, Gemmill and others 2011). An apparent difference between complication rates reported by surgeons and those reported by owners was found, as previously reported by Forster and others (2012). Even though the complication rate reported by owners was lower than that reported by veterinary surgeons, 4.3% and 8.2% respectively, it was found that in some instances perioperative complications were reported by the owners and not by the veterinary surgeon. This could be due to inadequate data input by veterinary surgeons, the animal being represented to a different referral veterinary surgeon when the complication occurs or unreliable data input by the owner.

A single case of protrusion acetabuli was reported. Protrusion acetabuli in this instance was classified as minor due to the lack of medical or surgical intervention reported, according to the definitions of Cook and others (2010). It is probable that the complication was perceived to be one that could not be surgically resolved.

The rate of aseptic loosening was 1.9%, similar to previously reported rates of 2.1% to 7.2% (Olmstead and others 1983, Massat and Vasseur 1994, Edwards and others 1997, Bergh and others 2006). The

postoperative complication rate of aseptic loosening is low suggesting that the mechanical failure of the implants, bearing surfaces or bone-implant/bone-cement interface is not a significant factor three years after canine THR. However, the reliance on both owners and veterinary surgeons to input data and the fact that cases of aseptic loosening have been described in the absence of clinical signs in dogs (Bergh and others 2006), means that the true incidence of aseptic loosening might be higher than reported herein. Owners might attribute a gradual deterioration in function to 'natural changes post operatively' and might not report changes to their veterinarian. The majority of cases of aseptic loosening were reported within the first six months following surgery. Aseptic loosening can be the result of mechanical or biological loss of fixation over time, or inadequate initial fixation. Evaluation criteria inclusive of the timing of imaging were not set for the identification of complications radiographically. It remains impossible to discern whether early reports of stem loosening are due to inadequate initial fixation or subsequent loss of fixation.

Subsidence of the femoral component can occur due to lack of osseous integration. Predisposing factors can include straight femora which lack an isthmus or with undersized femoral implants (Rashmir-Raven et al, 1992). A single case of subsidence was reported. This complication is under-reported when compared to other studies (Kidd SW, 2016).

A study reporting complications of human total hip arthroplasty reported that the rate of acetabular loosening increased from 2% at six years postoperatively to 42% at 11 years postoperatively (Mulroy and Harris 1990). Therefore, for example the absence of aseptic implant loosening in 140 CFX patients in the current study, is likely underestimating the true incidence, which in addition is likely rising over time. Cementless fixation of the acetabular component has become increasingly popular because the long-term results of cemented total hip have shown that late failure is associated with loosening of the acetabular component (Yee and others 2000, Skurla and James 2005, Bergh and others 2006). Interestingly, in the data reported in our study, aseptic loosening was reported with cementless prostheses only (BioMedtrix BFX cup/stem, Helica). It is possible that with longer follow-up times a different outcome may emerge such that cementless THR may result in longer survival and less aseptic loosening in comparison to cemented THR.

Complications reported using cementless femoral stems include subsidence, intra-operative femoral (fissure) fractures and post-operative femoral fractures (Pernell and others 1995, Liska 2004, Dyce 2005, McKee 2008). Predisposing risk factors for fracture of the femur after THR include osteopathy and iatrogenic fissures created during surgery (Liska 2004). Liska (2004) described an increased concentration of biomechanical forces at the distal end of the femoral stem as a plausible cause of femoral fracture. Cementless femoral fixation has been reported as a risk factor for femoral fracture for human total hip arthroplasty (Berend and others 2006). However after a fracture, femoral component survivorship was greater for cementless stems compared to cemented stems. Although the data is limited, overall it appears that many BFX complications relate to the femoral component, whereas the acetabular component is more reliable (McKee 2008). The results suggest BioMedtrix BFX has a high short-term complication rate, associated with the femoral stem. Overall the incidence of femoral fracture (2.9%) was greater for cementless prosthesis (5 BFX cup/stem, 2 Kyon) compared to cemented implants (1 hybrid BFX cup/CFX stem, 1 CFX cup/stem).

An overt limitation of this study is that surgeon experience is not analysed as a variable. The ability to categorise surgeon experience is a difficult one; whether this is based on number of years as a registered specialist, years since completion of a certified hip replacement teaching course, number of cases submitted or number of cases carried out per surgeon/clinic per year. When using years of experience/cases carried out as a determination of skill, it would prove difficult when reviewing data over a period of time, based on the need to alter this with each subsequent year. As detailed previously, during the initial set-up of the BVOA-CHR, participating surgeons signed a CDA with The University of Liverpool Veterinary School which is a legally binding agreement stating that the variables of “surgeon” or “clinic” will never be used in data analyses. In this way, we aimed to avoid any concerns caused by commercial sensitivities and to encourage data submission. Despite this agreement, the potential for lack of reporting by surgeons due to the negative connotations of reporting postoperative complications cannot be overlooked. This and the fact that the task of reporting in itself is time consuming could alter input and therefore outcome following surgery.

A noteworthy limitation of this study is that analysis of data is inclusive only of those surgeries occurring during or before December 2012. This analysis therefore does not account for variations in prosthetic

design subsequent to this point; for example the introduction of new generation BioMedtrix BFX femoral components (BFX Ti Plasma Spray Stem: 2012, BFX Ti EBM Stem: 2013). It is clear that at this time point, the low number of cases of BFX, Helica and Kyon designs do not allow for further subcategorising and statistical analysis. With ongoing collection and subsequent collation of data the number of cases per prosthetic type should increase the strength of further analyses.

Conclusion

There is owner satisfaction and a significant decrease in the LOAD score after THR, even when reported up to 36 months following THR. Complication rates from the BVOA-CHR are similar to previous studies. These first comparator results suggest a significant difference in complication rate with prosthesis type, with BioMedtrix BFX having a high short-term complication rate. The results are not suggestive of an association between aseptic loosening and the use of a cemented prosthesis type. However, the follow up time is relatively short.

366 Table 1. Prosthetic type cross-tabulated with Complication Type. Data recorded by surgeon or

367 owner, January 2010 – December 2012

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	Acetabular Fracture	Femoral Fracture		Luxation	Aseptic Loosening	Wound Complications	Other	Total Complications	Total Number of Cases
		Intraoperative	Postoperative						
BFX	-	1	4	2	2	3	1	13	39
CFX	-	1	-	5	-	2	3	11	140
Hybrid	2	-	1	1	-	3	1	8	74
Helica	-	-	-	2	4	-	-	6	34
Kyon	-	-	2	1	-	1	-	4	19
								42	306

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370 In some instances cases with complications had more than one type of complication i.e. Cases with

371 complications = 38, Total Complications = 42

372 Table 2. Prosthetic type cross-tabulated with Complication Severity (25). Data recorded by surgeon

373 or owner, January 2010 – December 2012

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	Catastrophic Complications	Major Complications	Minor Complications	Total Complications	Total Number of Cases
BFX	-	13	-	13	39
CFX	-	8	3	11	140
Hybrid	1	7	-	8	74
Helica	-	6	-	6	34
Kyon	1	3	-	4	19
				42	306

375

376 In some instances cases with complications had more than one type of complication i.e. Cases with

377 complications = 38, Total Complications = 42

Table 3. Prosthetic type cross-tabulated with Complication Occurrence. Data recorded by surgeon or owner, January 2010 – December 2012

	Number of Cases without Complications	Number of Cases with Complications	Total Number of Cases	Complication Rate %
BFX	29	10	39	25.6
CFX	130	10	140	7.1
Hybrid	66	8	74	10.8
Helica	28	6	34	17.6
Kyon	15	4	19	21.1
	268	38	306	12.4

In some cases, more than one type of complication occurred. However, statistical analysis was completed on the basis of whether the case had a complication, be that one or several.

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