Are Old Dogs Who Undergo Total Hip Replacement More Predisposed to Perioperative Femoral Fractures Than Young Dogs?

A Knowledge Summary by

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Clinical bottom line

There is currently insufficient evidence that old dogs undergoing total hip replacement are more predisposed to perioperative femoral fractures in comparison to young dogs.

Question

Are old dogs undergoing total hip replacement more predisposed to perioperative femoral fracture in comparison to young dogs?

The evidence

By reviewing the veterinary literature relative to the general complications and outcomes of total hip arthroplasty, a variation in the prevalence of femoral fractures was noticed. Regarding the design of these studies, the level of evidence provided is weak. Currently, there are insufficient strongly convincing studies in the veterinary literature.

Summary of the evidence

Liska (2004)	
Population:	Client-owned dogs.
Sample size:	22 dogs (n=22) with 24 femoral fractures (n=24)
Intervention details:	Two surgeons at different hospitals performed the same technique of modular hip replacement with cemented total hip replacement (THR) (BioMedtrix). One surgeon performed 20 of the THRs. For two dogs, THR was performed at other hospitals using the same technique and system. 1) fracture groups 2) non-fracture groups **Medical records evaluated:** **Radiographs** Ventrolateral and mediolateral of the affected femur. Pre- and postop during follow-up visits, fracture healing, and periodically after fractures were healed until either the patient died or the study ended. **Evaluated/identified** Interval between THR and femur fracture, orientation of fracture lines, events that occurred at fracture and treatment methods.

	Patient information Fixation method, joint alignment, bone healing implant integrity, bone-cement interface, implant-cement interface. **Limb function** Evaluated by examination and client interview and classified as either normal or good. Mean, median and range of numerical values were calculated for variables such as age, body weight, body score, bone healing and follow-up intervals. T-tests to compare fracture group and non-fracture group.
Study design:	Retrospective observational case-control study.
Outcome studied:	Objective: To report femur fracture as a complication of THR and to report the incidence, predisposing factors, treatment options and outcome.
Main findings: (relevant to PICO question):	Overall incidence of femur fracture after THR: 2.9%. **Age at THR** Dogs that had femur fractures were significantly older (7.4 years) at THR than dogs that did not sustain femur fractures (4.9 years) (p=0.0063). **Predisposing factors** Osteopathy (n=5) iatrogenic fissures created during reaming (n=9) and previous hip surgery. Fracture characteristics Fracture occurrence 22 after original THR, 1 after revision, 1 after explanation: • traumatic events in 17 dogs • osteopathy present at THR in 5 dogs • cortical thinning secondary to aseptic loosening in 3 dogs **Fracture treatment:** • plate and screw fixation (10 with and 7 without cerclage wires) resulted in the most favourable outcome - healing occurred in 6-10 weeks • full cerclages wires in 3 dogs • strict confinement in 3 dogs • euthanasia in 1 dog **Outcome:** • 22 fractures healed and there were no non-unions • two fractures that did not heal: 1 dog died 16 days after surgery of an unrelated illness and 1 dog was euthanised without treatment

	• 20 clients with a dog with a healed fracture were interviewed > 65 days after surgery: 12 dogs were alive at the end of the study - 15 clients (75%) reported normal limb function and 5 (25%) reported good limb function Old dogs with osteopathies, dogs that have had previous hip surgery, and dogs that have intraoperative fissures should be recognised as potentially being at greater risk of femoral fracture.
Limitations:	• retrospective study • different surgeons, different hospitals • surgeon experience was not evaluated as a risk factor • different follow-up • 10 dogs (45.5%) with fractures were followed until death • client interview

Ganz et al (2010)	
Population:	Client-owned dogs.
Sample size:	74 dogs (n=74), 84 total hip arthroplasty (THA) (n=84)
Intervention details:	Two different surgeons performed the same technique and modular hip replacement using BFX (BioMedtrix) from two referral hospitals. 1) fracture group (n=11) 2) non-fracture group (n=73) **Inclusion criteria** Cases with preoperative, immediate postoperative and initial follow-up radiographs. **Exclusion criteria** Dogs without complete surgery reports, dogs in the non-fracture group without documentation of absence of femoral fracture on recheck radiographs at least 4 weeks postoperatively. **Dog factors analysed** Age, breed, sex, weight, canal flare index (CFI), indication for arthroplasty, intraoperative fissure, cerclage usage, implant size. **Statistical analysis:** • preliminary univariate tests were performed and any factors with p>.30 were excluded for further consideration • continuous variables: non parametric Wilcoxon's rank sum test • binary variables: Fisher's exact test • factors included for multicollinearity were entered in to the logistic equation • previously deleted factors were singly added to the final

	model to reassess significance
Study design:	Retrospective observational cases cohort study.
Outcome studied:	To evaluate risk factors for femoral fracture after porous-coated cementless THA.
Main findings: (relevant to PICO question):	**Incidence femoral fracture:** • documented postoperatively 13.1% (11 of 84) • with complete statistical analysis 13.5% (7 of 52) This is higher than previously reported. It may partially represent a selection bias (dogs with complications are more likely to be seen for follow-up) and patients operated during the earlier part of the period were more likely to have incomplete medical records, this resulted in the exclusion of 12 dogs in the non-fracture group. **Dog factors:** • Age was positively associated with femoral fracture. Mean dog age was 7.3±0.69 years for fracture group and 4.77±0.37 years for non-fracture group (p=0.022). • CFI was negatively associated with fracture**.** Mean CFI was 1.80±0.09 for the fracture group and 1.98±0.04 for the non-fracture group (p=0.045). • Body weight, intraoperative fissure, cerclage use, implant size, position and canal fill did not influence the occurrence of femoral fracture. **Operative factors** Indications for THA: • coxofemoral osteoarthritis (OA) secondary to canine hip dysplasia (CHD) (n=78) • traumatic craniodorsal coxofemoral luxation (n=4) • coxofemoral OA secondary to capital physeal fracture (n=1) • femoral neck fracture malunion (n=1) **Intraoperative fissures** Reported in 3 cases. None of these dogs had femoral fractures. All fissures were addressed with cerclage wires. **Radiographic evaluation** None of the measures of implant positioning or canal fill were associated with risk of femoral fractures.
Limitations:	• retrospective study • small number of dogs in the fracture group (may have led to type II error) • different surgeons with 2 slightly different methods, 2 different hospitals and surgeon experience was not evaluated as a risk factor • partial selection bias possible • quality of radiographic positioning varied among patients • radiographs not evaluated from a board diplomate in

	radiology • canal flare index (CFI) not always available • length of radiographic and clinical follow-up varied • body score missing

Hummel et al (2010)	
Population:	Client-owned dogs that underwent Zurich cementless THR.
Sample size:	163 dogs (n=163)
Intervention details:	**Inclusion criteria** At least 8 weeks of documented postoperative radiographic and orthopaedic evaluations. **Exclusion criteria** THR performed as the second procedure in dogs operated bilaterally, previous ipsilateral coxofemoral surgery, cases without sufficient client communication. **Medical records of dogs** Sex, breed, age, body weight, body condition score, side of arthroplasty, date of surgery, history of previous contralateral coxofemoral surgery, urinalysis results, intraoperative surgical site culture results, lameness score at presentation (0=no lameness, 1=slight lameness, 2=obvious weight-bearing lameness, 3=intermittent non-weight bearing lameness, 4=continuous non-weight-bearing lameness) size of prostheses implanted, duration of surgery. **Complications were separated into:** • intraoperative (IOC) • short-term (STC) • long-term (LTC) Bivariate and multivariate statistical analysis was used to compare complications. Procedures were performed by 10 different surgeons.
Study design:	Retrospective cohort study.
Outcome studied:	To determine the prevalence of complications and identify prognostic indicators of success or failure for the Zurich cementless THR.
Main findings: (relevant to PICO question):	**Increased body weight** Prior femoral head and neck ostectomy (FHO) or cemented-THR in the contralateral joint was identified as a negative prognostic indicator for successful outcome ($p<0.05$).

	IOC overall IOC rate = 11% • fracture of the femoral diaphysis (n=12)=7.4% • fracture of the greater trochanter (n=3) • lost screw in soft tissue (n=1) • excessive haemorrhage (n=1) • immediate revision of acetabular cup placement (n=1) **STC** overall STC rate=6.75% • coxofemoral luxation (n=6) • transient neuraprexia (n=2) • fracture of the femoral diaphysis (n=2)(1.2%) • fracture of the acetabulum (n=1) **LTC** overall LTC rate=10.4% • septic loosening (n=6) • coxofemoral luxation (n=6) implant failure (n=4) fracture of the femoral diaphysis (n=1)(0.6%)
Limitations:	• retrospective • surgery performed by 10 different surgeons • follow-up performed in different ways and by different persons • relatively short scheduled radiographic follow-up (8 weeks) • 50 cases in which the 8 week follow-up was not performed by board certified specialists (surgery and radiology), body score not evaluated in all dogs • increased rate of complications higher than previous studies. Likely influenced in part by varying degrees of Z-THR experience (technical error) • surgeon's experience not evaluated as prognostic factor • no evaluation of technical errors immediately post operatively

Bergh et al (2006)	
Population:	Client-owned dogs that underwent cTHR at the University of Pennsylvania School of Veterinary Medicine.
Sample size:	97 dogs (n=97)
Intervention details:	**Medical records** Signalement, body weight, body condition score, diagnosis at the time of surgery, history of previous or subsequent hip surgery. **Complications**

	• intraoperative (IOC) • short term (STC) • long term (LTC) **Evaluation of radiographs** 2-view radiographic hip studies pre-operatively, immediately post-operatively and at the longest follow-up were evaluated by one investigator. **Pre-operatively** Severity of osteoarthritis (OA) was graded (0=normal, 1=subtle, 2=grade 0 or 1 with severe subluxation or luxation, 3=mild OA, 4=moderate OA, 5=severe OA). **Immediately post-operatively** Surgical technique (implant size, implant position, cement quality) and technical errors. Radiographs at the longest available follow-up and at least at 8 weeks post-operatively Evaluated and compared to the immediate post-operative films (fracture of cement, medullary infection, loosening of the acetabular component, prosthetic luxation, fracture of the femoral diaphysis or greater trochanter and infection). **Statistical analysis:** • categorical data: chi-square or Fisher's exact test • logistic regression analysis to access the independent contribution of possible risk factors Surgery performed by various board certified surgeons
Study design:	Retrospective cohort study.
Outcome studied:	To identify the prevalence of complications and changes following cTHR and to identify factors that may predispose to a need for revision surgery.
Main findings: (relevant to PICO question):	**Prevalence of complications:** 12.1% after primary cTHR **Pre-operative radiographs:** • available for 79 dogs • majority had severe OA **Post-operative radiographs (primary cTHR) (n=97):** • available for 87 dogs • 69 dogs had appropriately sized femoral implants • 60 dogs had eccentrically placed implants

	• angle of lateral opening of acetabular component was appropriate in 40 dogs **Post-operative radiographs (secondary cTHR) (n=8):** • available for 8 dogs • 7 dogs had appropriately sized femoral implants • 5 dogs had eccentrically placed implants • angle of lateral opening of acetabular component was appropriate in 3 dogs **Technical errors:** • primary cTHR - ≥1 technical errors in 43 dogs • secondary cTHR - technical errors in 50% of the dogs **STC** 1. primary cTHR available in 77 dogs ≥1 STC in 7 dogs 2. secondary cTHR (n=8) STC in 2 dogs. Luxation (n=1) and infection (n=1) **LTC** 1. primary cTHR available for 63 dogs 59 dogs with radiographic changes in the bone, cement or prosthesis 2. secondary cTHR available for 5 dogs, all had radiographic changes **Revision surgery:** 1. primary cTHR 12.1% (11/90) six had the implant removed, five had a revision (one femoral fracture) 2. secondary cTHR two dogs had a revision **Risk and protective factors:** • after primary cTHR dogs were more likely to have a revision surgery if the femoral implant was eccentrically placed (p=0.01) • presence of radiolucent lines at the femoral cement-bone interface in the long-term period was positively associated with revision surgery (p=0.02) male dogs were more likely to have revision surgery on the primary cTHR (p=0.05)
Limitations:	• retrospective (medical records incomplete, limited follow-up) • different surgeons with different experience • surgeon's experience not evaluated as risk factor • complications that were treated elsewhere or left untreated would not have been detected • variable radiographic technique and patient positioning (may have affected implant assessment) • some radiographic films with inadequate quality for evaluation

	• some body condition scores (BCS) were missing

Guerrero (2009)	
Population:	Client-owned dogs that had Zurich Cementless Total Hip Replacement (ZCTHR). **Inclusion criteria:** Medical records of the first 100 consecutives cases with 2nd generation ZCTHR were reviewed. Only those dogs that had clinical and radiographic evaluation with ≥ 6 months follow-up.
Sample size:	60 dogs (n=60) 65 ZCTHR (n= 65)
Intervention details:	All surgery was performed by the same surgeon. **Signalement data:** • age, breed, body weight, gender • indication for THR • hip dysplasia and secondary coxarthrosis (n=59), failure of conservative and/or surgical management of traumatic coxofemoral luxation (n=5), old Salter-Harris fracture of the proximal femoral physis (n=1) • date of surgery and operated size • cup position (angle lateral opening ALO, angle of inclination AI) Longest clinical and radiographic follow-up (presence of pain on manipulation of the hip joint, range of motion (ROM), muscle mass compared with the contralateral size, lameness). Evaluated using a score: excellent, good, fair, poor or failed. **Complications:** • intraoperative (n=1) femoral fissure during reaming • post-operative (n=11) femoral fracture (1), prosthesis luxation (7), cup loosening (2), implant failure (1) **Management of complications and outcome** Nine cases were successfully revised. Explanation of implants was performed in one case because of infection, one dog was euthanised after a new luxation.
Study design:	Retrospective descriptive case series.
Outcome studied:	To evaluate the use of, and to identify complications of the ZCTHR.
Main findings: (relevant to PICO question):	**Mean follow-up:** 22.68+/- 16.75 months

	Clinical outcome: • of 65 ZCTHR, 60 were considered to have an excellent outcome, 3 a good outcome, and 2 as failed • 97% good or excellent outcome at an average of 2 years post-operatively (similar to previous reported rates of 91-96%) • 17% needed one or more revision **Radiographic findings:** Findings compatible with bone ingrowth fixation were observed for all acetabular and femoral implants. Focal radiolucent zones were observed in the acetabular component of 23 cases and none of the THR had a complete radiolucent zone around the cup or the stem. **Complications:** (n=11, 17%) Previous complication rates 6.3%-20.3%. Luxation in cemented and cementless systems is the most frequently reported complication 1.1-11.8%, in this study: 11% (n=7). **Femoral fracture** (n=1) well-reported complication after THR in dogs, and appears to be more common in old animals because of nonuse of the leg or other pathologic conditions. This single femoral fracture compares similarly with fractures occurring with cemented THR systems. Increased femoral cortical thickening was observed along the medial cortex and distal to the stem in most cases. This bone remodeling and apposition may prevent occurrence of femoral fractures in the long-term that occur with cemented THR because of cortical thinning. **Component loosening** (acetabular component n=1) Implant stresses are higher in the ZCTHR stem compared with cemented stems, reaching a maximum in the neck region of the implant, with a second peak at the level of the most proximal screw.
Limitations:	• retrospective descriptive case series study, no control groups, variable follow-up • two ZCTHR were not evaluated radiographically

Forster et al (2012)	
Population:	Client-owned dogs that underwent THR.
Sample size:	170 dogs (n=170)
Intervention details:	Entries into the British Veterinary Orthopaedic Association-Canine hip Registry (BVOA-CHR) were reviewed.

	Variables evaluated: • age, body weight, breed, indication for THR and prosthesis **Statistical analysis:** • association between each variable and the incidence of complications were assessed using logistic regression • Mann-Whitney U-Test was performed to assess the significance of total lameness scores before and after THR Owner outcomes assessment questionnaire was used additionally to collect data from owners. **Divided in 4 sections:** • Section A assessed information regarding length of ongoing mobility problem, medications received, and other concurrent medical history unrelated to hip dysplasia (HD). • Section B assessed activity and willingness to exercise before THR. • Section C assessed date of surgery, overall owner satisfaction and complications. • Section D assessed activity and willingness to exercise after THR. **Surgical implants** CFX (BioMedtrix), BFX, Helica, Kyon
Study design:	Prospective case series.
Outcome studied:	To assess the variables associated with the complications of THR and report owner-assessed outcomes, through surgeon-based registration of cases via an online database, informed owner consent and prospective outcomes assessment using a client-administered clinical metrology instrument.
Main findings: (relevant to PICO question):	**Complications** Incidence: 9.4%: • luxation (n=5) • femoral fractures (n=3) • minor wound dehiscence • (n=1) wound sepsis, (n=1) protrusion acetabuli, (n=1) acetabular cup displacement, (n=1) suspected pulmonary thromboembolism and death at the end of surgery • (n=1) femoral pain, (n=1) femoral subsidence, (n=1) siatic paresis and luxation (n=5), femoral fracture (n=3), minor wound dehiscence (n=1) No statistical significance was identified between weight, age, gender, breed, indication for THR, surgical technique and prosthesis

	and incidence of complications. **Client questionnaire:** A total of 51% response rate to the online owner assessment questionnaire was achieved. 82% described their satisfaction with the outcome of THR as “very good”, 12% “good”, 7%”fair”, 0% “poor”, 0% “very poor”. A total of 20% complication rate was reported statistically significant difference in owner-assessed lameness scores before and after THR ($p<0.001$). Participating surgeons were requested to submit all of their operated cases to the BVOA-CHR (authors unable to control it). In theory it is possible that participating surgeons may have chosen not to submit data from a case with a less successful outcome (selection bias). The complication rate in this study would therefore be higher than documented.
Limitations:	Participating surgeons were requested to submit all of their operated cases to the BVOA-CHR (authors unable to control it). In theory it is possible that participating surgeons may have chosen not to submit data from a case with a less successful outcome (selection bias). The complication rate in this study would therefore be higher than documented. • client assessment subjective, no controls with force platform peak vertical force for example • 51% response rate to the online owner assessment questionnaire • different complications rate between owners and surgeons • THR was most frequently performed on dogs ≤ 1year (39%) • limited ability to fully evaluate the risk factors for THR complications to date, probably because most studies are single-center and have limited power • BVOA-CHR does not currently include imaging data

Appraisal, application and reflection

The aim of this Knowledge Summary was to review, summarise and critically appraise the literature regarding the question: Are old dogs undergoing total hip replacement predisposed for perioperative femoral fractures in comparison to young dogs?

This reflection was investigated in two observational retrospective studies: Liska (2004) and Ganz et al. (2010). Both studies reported that elderly dogs undergoing THR may be at an increased risk of femoral fractures. According to Liska (2004) old dogs with osteopathies, previous hip surgery and iatrogenic fissures created during reaming are predisposing factors for femur fracture after THR. The overall incidence of femur fracture after THR was 2.9%. The author describes an excellent prognosis when the fractures were treated correctly. Due to the design of the study (observational and retrospective) and the limitations (retrospective, different surgeons, surgical method/surgical experience not evaluated as a risk factor, different follow-up) the results have to be interpreted with caution.

Ganz et al. (2010) evaluated the risk factors for femoral fracture after canine press-fit cementless total hip arthroplasty. The conclusions were that older dogs and dogs with lower CFI may be at increased risk of femoral fracture and the incidence of femoral fracture of cases with complete statistical analysis was 13.5%. Regarding the design of this study (observational and retrospective) and its limitations (retrospective, different surgeons, surgical method/surgical experience not evaluated as a risk factor, different follow-up) the level of evidence provided by this type of study is weak. However, the results of these studies can be used to counsel clients before performing THR in old dogs.

By reviewing the veterinary literature relative to the general complications and outcomes of total hip arthroplasty, a variation in the prevalence of femoral fractures was noticed. None of the studies listed above mentioned that the age of the patient may be a potential risk factor for general complications. Again, due to the design of all of these studies the level of evidence is weak.

In the study of Hummel et al. (2010) the prevalence of femoral fractures occurring intraoperatively was 7.4%, the prevalence of femoral fractures occurring as short-term complications was 1.2% and the prevalence of femoral fractures occurring as long-term complications was 0.6%. Increased body weight and prior cemented THR or femoral head and neck ostectomy of the contralateral hip were identified as negative prognostic factors.

Berg et al. (2006) described a 1.3% prevalence of femoral fracture occurring during the primary THR as short term complications, and fracture of femur diaphysis represented 3.2% of the long term complications. Eccentric positioning of the femoral stem and the presence of radiolucent lines at the femoral cement-bone interface were positively associated with the occurrence of revision surgery.

The prevalence of femoral fracture post-operatively in the study of Guerrero and Montavon (2009) was 1.5%. Forster et al. (2012) identified no significant association between weight, age, sex, breed, indication for THR, surgical technique and prosthesis and the incidence of complications of total hip arthroplasty. The incidence of surgeon-reported surgical complications was 9.4%. The femoral fractures represented 18.75% of the complications.

In conclusion, there is insufficient evidence that elderly dogs undergoing THR are predisposed to femoral fractures in comparison to young dogs. Currently, there are insufficient strongly convincing studies in the veterinary literature to support the results of Liska (2004) and Ganz et al. (2010).

Methodology Section

Search Strategy	
Databases searched and dates covered:	CAB Abstracts (1973-2015) accessed on the OVID platform Vetmed Resource (1973-2015)
Search terms:	dogs OR dogs OR canine AND femoral fractures OR femur OR femoral OR fracture AND total hip replacement OR total hip arthroplasty OR cemented total hip replacement OR cementless total hip replacement OR uncemented total hip replacement OR cemented total hip arthroplasty
Dates searches performed:	December 2015

Exclusion / Inclusion Criteria	
Exclusion:	Non English language, conference papers, summary updates, case reports, reviews.
Inclusion:	Studies which were looking for risk factors and outcomes in total hip replacement, studies which described femoral fractures as complications. Experimental studies and observational studies.

Search Outcome

Database	Number of results	Number of duplicates	Excluded – not English language	Excluded – due to study design	Excluded – did not answer PICO question	Total relevant papers
CAB Abstracts	194	14	19	34	127	6
Vetmed Resource	7	0	3	1	3	1
Total relevant papers when duplicates removed						7

CONFLICT OF INTEREST

The author declares no conflict of interest.

REFERENCES

1. Bergh, M.S. et al. (2006) Complications and radiographic findings following cemented total hip replacement A retrospective evaluation of 97 dogs. *Veterinary and Comparative Orthopaedics and Traumatology*, 19 (3), pp. 172-9.
2. Forster, K. E. et al. (2012) Complications and Owner Assessment of Canine Total Hip Replacement: A Multicenter Internet Based Survey. *Veterinary Surgery*, 41 (5), pp. 545-550.http://dx.doi.org/10.1111/j.1532-950X.2012.01015.x
3. Ganz, S.M. Jackson, J. and VanEnkevort, B. (2010) Risk Factors for Femoral Fracture after Canine Press-Fit Cementless Total Hip Arthroplasty. *Veterinary Surgery*, 39, pp. 688-695.http://dx.doi.org/10.1111/j.1532-950X.2010.00694.x
4. Guerrero, T.G. and Montavon, P.M. (2009) Zurich Cementless Total Hip Replacement: Retrospective Evaluation of 2nd Generation Implants in 60 Dogs. *Veterinary Surgery*, 38 (1), pp. 70-80.http://dx.doi.org/10.1111/j.1532-950X.2008.00466.x
5. Hummel, D.W. Lanz, O.I. and Werre, S.R. (2010) Complications of Cementless Total Hip Replacement A Retrospective Study of 163 Cases. *Veterinary and Comparative Orthopaedics and Traumatology*, 23 (6), pp. 424-432. http://dx.doi.org/10.3415/VCOT-09-07-0071
6. Liska, D.W. (2004) Femur Fractures Associated with Canine Total Hip Replacement. *Veterinary Surgery*, 33 (2), pp. 164-172. http://dx.doi.org/10.1111/j.1532-950X.2004.04024.x

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