Outcomes for Total Joint Replacement in Dogs and Cats

William D. Liska, DVM, DACVS
Gulf Coast Veterinary Specialists
Houston, TX

Patient function, quality of life, and return to intended purpose in life ultimately define the clients' satisfaction. As veterinary orthopedic surgeons, we are increasingly more subjected to higher expectations from our clients with active companions. Owners expect rapid recoveries and outcomes that are equal to normal joints following joint replacement. The historic paradigm of delaying surgical intervention for patients with joint pain until such time that it is unbearable no longer applies to dogs. End stage osteoarthritis of the hips that incapacitated dogs was once almost a death sentence only a few decades ago. Obviously, and thankfully, those days are long gone. Veterinarians are aware of the human-animal bond and we realize the value our clients place on their companions. In addition, many animals have an economic and social value for numerous reasons. In present times, client fear, dread, or anticipated guilt about signing a euthanasia form due to the impact of non-terminal diseases like debilitation from osteoarthritis leads to their determination to find interventions to resolve joint pain including surgery if necessary. Clients and referring veterinarians have high expectations of providing surgical interventions backed by objective evidence about long-term results and success. Rapid recovery and high performance are expected – not just hoped for. Joint replacements are now considered a suitable option for joint pain. Intervention in young patients is requested, is feasible, and is more common because technology has provided us with implants with a longer "life expectancy" than that of our patients.

Canine joint replacement technology and surgeon expertise have advanced greatly over the last 20 years. At the same time, management of preoperative, perioperative, postoperative, and chronic pain have received considerable attention. Only a few relatively small companies worldwide supply the technology for joint replacement surgery and a relatively low number of surgeons have the expertise and high volume joint replacement practices to consistently perform the procedures with a high degree of repetition and proficiency. Joint replacement technology must compete with giant pharmaceutical companies with easily marketed excellent products and massive budgets that generate revenue for primary care veterinarians. There is no risk of treating patients that will not "discuss" their lingering low level of pain or incapacitation – if indeed it exists at all. As a consequence, the pain management era competition may be having a temporary detrimental impact on the growth and progress of joint replacement surgery in dogs and cats and secondarily a quality of life that could be better.

A few options, such as physical therapy and medical management, are available for dogs with chronic osteoarthritis and presumable chronic joint pain. Medical management of osteoarthritis will always be the first treatment option. In humans, medical management does not completely and indefinitely relieve pain once the progression of disease reaches a critical point as evidenced by the fact that approximately 1.3 million joint replacement surgeries are performed annually in this county. Other surgery options exist for our canine and feline population. A femoral head ostectomy for the hip is an option, but no conclusive studies with objective evidence, such as recent reliable force plate gait analysis data, could be found that document return to "normal" function as is available following total hip replacement surgery.

Clients expect their companions to return to high levels of activity following hip replacement surgery. Even older patients with chronic arthritis or other disease processes are expected to have a rapid recovery and to regain pain free full function exceeding levels previously never considered possible. In most instances, the expectations of outcomes for dogs appear to be higher than what human patients expect for themselves if they undergo the same procedure. In one human study, only 16% of the patients reported participating in manual labor or sports deemed "not recommended" by the surgeon. In another study, clients' expectations of surgical results were lower than the surgeons' expectations. Some human patients undergoing hip replacement expressed concerns about the ability to continue with certain recreational and sporting activities, or to begin new activities after the procedure. Following THR, 5 sports showed significant change in patients' participation from pre to post-operation. Participation increased in walking exercise (16.8%) ($P < 0.0001$) and aqua aerobics ($P=0.002$). Participation in three sports decreased significantly: golf ($P=0.005$), tennis ($P=0.01$), and jogging ($P=0.01$). The total number of patients exercising following joint replacement increased postoperatively, but the total amount of vigorous activity decreased. This kind of decrease in vigorous activity levels allowed is not acceptable to most dog owners, especially those with young animals.

Rationale for exercise recommendations after total joint replacement in humans can be applied to our veterinary patients. For humans, current recommendations encourage individuals to remain physically active for general health and bone quality. Considerations for certain activities after THR and TKR are determined by factors such as wear, joint load, exercise intensity, and type of prosthesis for each patient and each sport. Wear reduction is considered one of the main factors affecting long-term results after joint replacement. Wear is dependent on load, number of cycles, and material properties. Endurance physical fitness is recommended several times per week with high intensity. Because load influences the amount of wear exponentially, only activities with low joint loads such as swimming, cycling, and possibly power walking are recommended. It is unwise to start technically

demanding activities after joint replacement such as contact sports. Suitable activities are different following hip replacement versus knee replacement. Following knee replacement, knee flexion and extension angles at peak load must be considered and moderated. Following total hip replacement, which involves a simple ball and socket joint, flexion and extension angles do not play a significant role. A high degree of joint conformation designed into knee replacement implants is more favorable since the loads are dispersed over a greater surface area, which will in turn decrease points of wear. It is prudent to be more conservative after knee replacement than after hip replacement.

It is unknown to what extent and how quickly dogs can resume vigorous or strenuous activity following joint replacement even though anecdotal evidence demonstrates safe return to an extremely high level of activity including weekend warriors, hunting, performance in the show ring, field trials, return to work as law enforcement dogs, endurance activity running with clients many miles per week, and return to duty as service dogs. As veterinarians, our expectations should be realistic and not expect dogs to compete at elite levels of activity, such as competing in events like The Iditarod Sled Dog Race, or to accompany their human owners in triathlon competition. Rarely do human patients' expect to progress to function and activity levels that were not achievable prior to the onset of their osteoarthritis. The contrary is true with canine patients; owners often ask if their young dog undergoing hip replacement surgery will be able to carry out recreational or work activities that were never achievable before surgery.

A paradigm shift is in order in recommending hip replacement surgery from "wait until it is absolutely necessary because nothing else works any longer" to "sooner rather than later". Months and even years of oral antiinflammatory medication, years of joint health support product injections, acupuncture, holistic medicine, chiropractic, and even waiting for the owner's card reader to decide on proper timing for joint replacement surgery have been encountered. These are not valid reasons to delay surgery considering the high degree of success of the THR procedure. Hip replacement implants are expected to "outlive" the patient so delaying surgery over concerns about implant wear is not justified.

Additional "scientific validity" is a good thing. Multiple references validating total hip replacement intervention are available and adequate for the veterinary profession to proceed with hip replacement surgery. Innovation is not new and should not be unexpected. Joint replacement surgery will evolve including continued development of hip replacement for small dogs and cats, knee replacement, and elbow replacement surgery. Almost all surgical techniques improve with time and joint replacement surgery is no exception. Almost none of the orthopedic procedures we perform routinely today were adopted only after rational evaluation of evidence was accumulated in randomized controlled studies. On the other hand, while we should not adopt new techniques out of boredom or a need for the "latest" and the "greatest", we cannot always wait for years of follow up of well-designed prospective randomized studies to be convinced that anything new might actually be acceptable to try even when all indications are that it is better alternative to current options. We should remain open-minded but at the same time be critical of results and rely on objective data while staying wary of subjective reports.

The ideal joint prosthesis would mimic the anatomy, kinetics, and kinematics of a normal contralateral joint. Implant design, surgical technique, and surgeon judgment affect proper restoration of the anatomical integrity. Incomplete restoration creates the possibility of biomechanical dysfunction, subtle functional deficits, accelerated prosthesis wear, and ultimately the potential for complications or joint replacement failure. This is particularly true in the patient that is expected to return to strenuous, high impact, and/or endurance activity.

The patient's aftercare and rehabilitation can be critical in defining ultimate performance outcomes after surgery. Rehabilitation should be part of the preoperative conversation and preparation, and rehabilitation should continue throughout patient recovery. A realistic prognosis must be provided preoperatively. Risks and complications should clearly be discussed and be well understood by the client. All of these factors take a considerable amount of effective and consistent communication between the doctor/hospital staff and the client.

What is necessary to allow animals with joint replacements to lead an active life?

A. Perform surgery sooner rather than later before muscle and bone atrophy is present.

B. Secure fixation of joint prosthesis implants is mandatory for long-term success of active patients. Cemented and cementless fixation methods are used. Cemented fixation of hip prosthesis implants has been successful for well over 20 years but is technique sensitive. Cementless fixation has gained great popularity since 2003. Bone ingrowth into the porous prosthesis surface provides the ultimate long-term fixation with one less variable of concern during the prosthesis life – the bone cement. Cementless fixation is also technique sensitive with greater precision demands during implant bed preparation. Aseptic loosening is a major cause of joint replacement revision or explantation. Loosening may be of mechanical or biological origin. Wear debris causing an inflammatory reaction at the implant-bone or cement-bone interface can result in loosening. Unrecognized infection is another possible etiology of interface failure.

C. Use implants with superior wear characteristics. The average human patient exerts 1.426 million loading cycles on each hip per year and polyethylene wear is multi-factorial including time, level of activity, patient weight, femoral head surface finish, and polyethylene deterioration. Understanding tribology, the study of motion, friction, and wear, helps improve implant survival. A ten-year follow up study was conducted evaluating radiographic measurements of polyethylene wear with primary cementless THR in humans. The average follow up period was 132 months. The average total wear rate was 0.11mm per year. The degree of wear during the first two years accounted for 40% of the total wear in the study. Femoral head migration during the first 3.4 months after surgery accounted for 56% of the amount of wear during the first two years. Wear rates gradually decreased with time and stabilized after the fourth year. Wear rates should be evaluated in dogs to better understand such issues as the effect of quadruped versus bipeds on wear rates, and the effect differences in body weight has on smaller implant surfaces.

D. Ensure accurate anatomical positioning. Millimeters are critical in hip and knee replacement surgery in people. Millimeters may be even more important in dogs with shorter limbs. The affect should be studied.

E. Provide rehabilitation of soft and hard tissues. Rehabilitation should be customized for each patient based on client interview, therapist evaluation of the patient, surgical technique, surgeon expertise and preferences, and activity goals for the patient to reach. Protocols are generally divided into four phases. It is advisable to discuss rehabilitation techniques available to assist patient recovery either prior to surgery or at the time of patient release from the hospital.

    1. Phase I begins immediately after THR surgery and may last up to 14 days. Wound protection, pain control, and minimization of soft tissue swelling and joint effusion are the primary goals. Interventions include appropriate modalities and manual therapies, including passive range of motion. Early mobility is restricted but supported, using slings as needed. By the end of this phase, weight bearing should be well tolerated and gait should be independent. Full passive range of motion exercise should be achieved.
    2. Phase II begins when inflammation subsides and continues through week 6. This is still a time of restricted activity to allow the joint capsule to heal and provide joint stability to allow bone on growth onto, or ingrowth into, the prosthesis. The bone begins to remodel in response to the new stress distribution around the prosthesis. Conservative therapeutic exercise may be initiated for strengthening and normalization of gait patterns and routine daily functional activities. Range of motion should continue to improve along with improvement of motor control and muscle endurance.
    3. Phase III continues during weeks 7 through 12. Controlled progressive increased levels of activity restore muscle strength and flexibility. Increased load and weight-bearing occurs with increased activity and the tissues respond accordingly. Balance, coordination, and joint proprioception should approach normal levels.
    4. Phase IV continues during the ensuing months until activity levels at the desired peak are achieved. This phase may take 3 to 6 months. Continued restoration of muscle strength, coordination, and power are achieved through progressively more strenuous and higher impact activity. Muscle mass increases and cortical hypertrophy occurs to accommodate new loads placed on the bone at the tip of the femoral stem. Overuse of the limb should be prevented with progressively increased use, avoiding dramatically increased activity over a short time period or "weekend warrior" syndrome. Regular evaluations by the therapist and surgeon are advisable if extreme high levels of activity and performance are desired. Objective data about rehabilitation progress on muscle mass and range of motion should be gathered from the patient with lofty goals to ensure the patient is progressing satisfactorily. Full function should be restored. Radiographs should be obtained to monitor prosthesis interfaces and bone quality where increased loads are being applied. Functional data should show overall improvement from preoperative measures.
    5. Following TKR, the same basic phases and goals are encountered but patient recovery is slower. Restoration of passive range of motion (PROM) does not occur as quickly. Because many patients are significantly impaired preoperatively, many to a point of non-weight bearing, restoration of muscle function and high level activities also occur over a longer time period.

F. At this time, objective rehabilitation outcome data is limited due to the lack of control studies that include control groups that do not progress through standard THR and TKR protocols. Further studies are needed to evaluate the hypothesis that rehabilitation improves long-term performance. In human patients, sports medicine studies on joint rehabilitation show consistent trends toward improved scores in all functional tests. Perform regular radiographic follow up examinations to monitor implant systems and to provide the surgeon with information for understanding and self assessment of skills. Two human studies conducted on human THR patients evaluated bone resorption in the proximal femur: a prospective 84-month follow up and a median 156-month cross sectional study using DEXA. Cumulatively, the studies found the initial remodeling process occurs in bone mass density (BMD) during the first 12

months, after which time no relevant further bone loss occurs. BMD had no further bone loss at 84 months after surgery and the values were similar to those values obtained 156 months after surgery. DEXA studies are not reported in canine patients to the authors knowledge. Cortical hypertrophy was seen radiographically in 6% of human patients in another study. Cortical hypertrophy may not be as frequent in human patients as in dogs because the human patients do not necessarily resume "normal" activity in spite of pain-free joints due to advanced age compared to the canine population receiving THRs. On the other hand, human patients with uncemented femoral stems had markedly more thigh pain and radiopharmaceutical uptake observed with scintigraphy at the stem tip 2.5 years after surgery. The patients had a high incidence of bone hypertrophy around the stem tip compared to those without thigh pain, suggesting stress transfer as a cause of thigh pain. Thigh pain is not a recognized entity in dogs unless a non-displaced fracture is present. A human study was conducted to evaluate tight distal stem and collar seating in hips with a cylindrical distal stem, collar, and proximal porous coating. Pain was significantly more likely to occur in patients with a loose distal fit. Distal hypertrophy occurred in 24 of the 67 hips with a tight distal fit, and a tight distal fit did not prevent proximal hypertrophy. A tight distal fit is associated with more complete pain relief in cementless THR and a tight distal fit does not prevent proximal load bearing.

G. Surgeons should accept existing implant designs and instrumentation. Surgeons should probably spend more time perfecting their own skills than requesting more implant/equipment upgrades and innovation.

The Internet provides extensive information, including information sometimes leading to unrealistic client expectations. Today, and in the future, we must be prepared with new knowledge of surgical techniques, rehabilitation, a prognosis based on objective data, pain control, and ever-changing new technologies to allow our patients to return to active lives.

Finally, high performance by the surgeon and the hospital staff are necessary to produce high performance from our patients. Specialty care can elevate the level of self-proclamation when in reality there are wide variations in skill levels among surgeons and hospitals' patient support abilities.

References

Dahm DL, Barnes SA, Harrington JR, Sayeed SA, Berry DJ. Patient-reported activity level after total knee arthroplasty. J Arthroplasty. 2008 Apr;23(3):401-7.

Moran M, Khan A, Sochart DH, Andrew G: Expect the best, prepare for the worst: surgeon and patient expectation of the outcome of primary total hp and knee replacement. Ann R Coll Surgery Engl. 2003 May;85(3):204-6

Chatterji U, Ashworth MJ, Lewis PL, Dobson PJ: Effect of total hip arthroplasty on recreational and sporting activity. ANZ J Surg. 2004 Jun;74(6):446-9.

Kuster MS: Exercise recommendations after total joint replacement: a review of the current literature and proposal of scientifically based guidelines. Sports Med. 2002;32(7):433-45.

Markel D C, Kester M: High Performance: What is it and why we need it, Seminars in Arthroplasty Vol 17:2, p 31, June 2006.

Goldsmith AA, Dowson D, Wroblewski BM, Siney PD, Fleming PA, Lane JM: The effect of activity levels of total hip arthroplasty patients on socket penetration. J Arthroplasty. 2001 Aug;16(5):620-7.

Dai X, Omori H, Okumura Y, Ando M, Oki H, Hashimoto N, Baba H: Serial measurement of polyethylene wear of well-fixed cementless metal-backed acetabular component in total hip arthroplasty: an over 10 year follow-up study. Artif Organs. 2000 Sep;24(9):746-51.

Aldinger PR, Sabo D, Pritsch M, Thomsen M, Mau H, Ewerbeck V, Breusch SJ: Pattern of periprosthetic bone remodeling around stable uncemented tapered hip stems: a prospective 84-month follow-up study and a median 156-month cross-sectional study with DXA. Calcif Tissue Int. 2003 Aug;73(2):115-21.

Pitto RP, Schramm M, Hohmann D, Schmidt R: Clinical outcome and quantitative evaluation of periprosthetic bone-remodeling of an uncemented femoral component with taper design. A prospective study. Chir Organi Mov. 2001 Apr-Jun;86(2):87-97.

Herzwurm PJ, Simpson SL, Duffin S, Oswald SG, Ebert FR: Thigh pain and total hip arthroplasty: scintigraphy with 2.5-year followup. Clin Orthop Relat Res. 1997 Mar;(336):156-161.

Whiteside LA: The effect of stem fit on bone hypertrophy and pain relief in cementless total hip arthroplasty. Clin Orthop Relat Res. 1989 Oct;(247):138-47.