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A Review

Treatment of Canine Hip Dysplasia: A Review

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Abstract

Hip dysplasia, one of the most common orthopaedic diseases in dogs, can lead to chronic pain and functional impairment (Lust *et al.*, 1973). Hip joint laxity is considered a major risk factor leading to abnormal weight-bearing forces and subsequent development of osteoarthrosis (Riser, 1975 and Frost, 1989). However, direct cause and effect between instability and osteoarthrosis has not been established (Prieur, 1980); while dogs that are affected with osteoarthrosis due to hip dysplasia show laxity, not all dogs that show laxity develop osteoarthrosis (Wright and Mason, 1977 and Smith, 1992). Osteoarthritic hip joints can benefit from early detection and subsequent treatment. Physical therapists have long utilized manual testing techniques and clinical reasoning to diagnose early-onset joint osteoarthritis and therapeutic treatments consisting of correcting muscle dysfunctions, relieving pain, joint mobilizations, and advisement on lifestyle modifications could be equally beneficial to the canine patient. As well, sacroiliac joint dysfunctions may also afflict the dog. An understanding of the anatomy and biomechanics of the canine sacroiliac joint and application of clinical assessment and treatmenttechniques from the human field may be substantially beneficial for dogs suffering from lumbopelvic or hindlimb issues (Edge-Hughes, 2007).

Keywords: Canine hip dysplasia, hip joint

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Introduction

Hip dysplasia, one of the most common orthopaedic diseases in dogs, can lead to chronic pain and functional impairment (Lust *et al.*, 1973). Hip joint laxity is considered a major risk factor leading to abnormal weight-bearing forces and subsequent development of osteoarthrosis (Riser, 1975 and Frost, 1989). However, direct cause and effect between instability and osteoarthrosis has not been established (Prieur, 1980); while dogs that are affected with osteoarthrosis due to hip dysplasia show laxity, not all dogs that show laxity develop osteoarthrosis (Wright and Mason, 1977 and Smith, 1992).

Osteoarthritic hip joints can benefit from early detection and subsequent treatment. Physical therapists have long utilized manual testing techniques and clinical reasoning to diagnose early-onset joint osteoarthritis and therapeutic treatments consisting of correcting muscle dysfunctions, relieving pain, joint mobilizations, and advisement on lifestyle modifications could be equally beneficial to the canine patient. As well, sacroiliac joint dysfunctions may also afflict the dog. An understanding of the anatomy and biomechanics of the canine sacroiliac joint and application of clinical assessment and treatment techniques from the human field may be substantially beneficial for dogs suffering from lumbopelvic or hindlimb issues (Edge-Hughes, 2007).

Therapeutic recommendations for affected patients can be confusing due to the unpredictable progression of clinical disease and the lack of published scientific data documenting the long-term efficacy of treatments. The purpose of this paper is to clarify and discuss current treatment approaches and recommendations for canine hip dysplasia.

For treatment purposes, clinically affected dysplastic dogs have been divided into animals with no or minimal osteoarthrosis, and those with radiographic evidence of moderate to severe osteoarthrosis. Treatment in dysplastic dogs with no or minimal osteoarthrosis Dogs that have joint instability, with minimal or no radiographic evidence of osteoarthrosis, are usually immature or young adult animals. These dogs may not show any signs of hip pain, or they may exhibit a sudden onset of unilateral or bilateral hindlimb lameness. Pain and lameness are associated with microfractures of the acetabular rim and periosteal injury (Barr, *et al.*, 1987). Treatment is recommended when both joint laxity and pain are exhibited. There have been no published reports to support prophylactic surgery in dogs with joint instability but no coxofemoral pain. Treatment in these dogs can be conservative or surgical. Conservative management consists of the administration of analgesics or chondroprotective agents, weight reduction, and exercise restriction. Options for surgical treatments include pectineal myectomy, lengthening of the femoral neck, and corrective osteotomies.

Conservative Management

Conservative treatment in dysplastic young dogs is directed towards alleviation of pain. The criteria for treatment selection and the long-term efficacy of conservative management are not well defined. Most clinically dysplastic young dogs without, and even with, osteoarthrosis will respond to conservative management. It has been reported that with conservative treatment alone, young dogs with joint laxity and pain have a 72% probability of returning to a comfortable and functional state after 18 mo of age (Smith, 1992). In addition, due to the unpredictable progression of the clinical disease, signs of pain or lameness may occur chronically in some, but not all, dysplastic dogs. A study of 68 dogs diagnosed with hip dysplasia when they were immature showed that there were minimal clinical signs of osteoarthrosis following conservative management when the dogs were checked 41/2 y later (Lipowitz, 1993). As conservative management does not cure hip dysplasia, the development of debilitating osteoarthrosis may still occur. Analgesics, chondroprotective agents, weight reduction, and exercise restriction have been used to decrease the clinical signs of pain (Palmoski and Brandt, 1979). Nonsteroidal anti-inflammatory drugs (NSAIDs), including aspirin, phenylbutazone, and meclofenamic acid, are commonly used to provide analgesic and anti-inflammatory effects.

The mechanism of action of NSAIDs is through inhibition of cyclooxygenase, which is responsible for the production of prostaglandins from

arachidonic acid. There is evidence to suggest that while NSAIDs are anti-inflammatory and provide effective pain relief,

most of these compounds actually accelerate cartilage degeneration by suppression of chondrocyte proteoglycan synthesis in the osteoarthritic environment (Palmoski, *et al.*, 1980). Some nonsteroidal drugs, such as piroxicam, have no adverse effects on cartilage synthesis (Burhardt and Ghosh 1987).

Side effects of NSAIDs are infrequent but potentially devastating. Gastritis, nephrotoxicity, decreased platelet aggregation, and gastrointestinal ulceration may occur (Wallace *et al.*, 1990; Jones *et al.*, 1992). The occurrence and severity of side effects is dependent on the type of medication, the dose given, and the frequency of administration. Ibuprofen and indomethacin cause a relatively high frequency of gastric ulceration because of their low margins of safety in drug concentrations. In addition to a low margin of safety in dogs, naproxen also has a long elimination half-life, thus increasing the potential for occurrence of side effects (Roudebush and Muse, 1981; Daehler, 1986). To counter the negative gastric effects of NSAIDs, a synthetic prostaglandin E1 analogue, misoprostol, has been developed and used experimentally (Murtaugh, *et al.*, 1993). Misoprostol prevents ulcer formation and helps ulcers heal through stimulation of gastric mucus and bicarbonate production, increased cell proliferation and migration, and increased gastric mucosal blood flow. Results of a clinical trial showed significantly fewer gastrointestinal complications in dogs treated with misoprostol and aspirin than in those treated with aspirin alone (Murtaugh, *et al.*, 1993).

Corticosteroids inhibit both cyclooxygenase and lipoxygenase pathways, and are effective in treating acute inflammation. However, chronic parenteral and intra-articular administration of corticosteroids causes cartilage matrix degeneration by inhibiting proteoglycan and cartilage biosynthesis by chondrocytes, thereby enhancing the rate of joint deterioration (Moskowitz, *et al.*, 1970). Intraarticular administration of corticosteroids can also result in iatrogenic septic arthritis. As such, corticosteroids should be used only as a last resort in the treatment of hip dysplasia.

Chondroprotective agents, including polysulfated glycosaminoglycans (PSGAGs), pentosan polysulfate, and chondrotin sulfate and glucosamine, have been used to treat cartilage injuries in horses and dogs. Although their mechanism of action is not fully understood, these agents are thought to stimulate proteoglycan and hyaluronic acid synthesis, and to inhibit proteases in the synovial fluid (Burhardt and Ghosh, 1987; Moskowitz, *et al.*, 1970). Recently, PSGAGs have been used prophylactically in puppies susceptible to hip dysplasia. Puppies treated 2x per wk with IM injections of PSGAGs showed less subluxation than did untreated animals (Lust, *et al.*, 1992). Although these chondroprotective substances show some promise in decreasing the severity of osteoarthrosis, it must be emphasized that their effectiveness in clinical dysplastic disease is not well established (DeHaan, *et al.*, 1994).

Body weight management is important in decreasing weight-bearing stresses on joints and supporting soft tissues. Obese puppies with hip dysplasia had more degenerative joint disease than did those whose diet was restricted (Olsson, 1978). Restricted exercise is also important in decreasing trauma-induced inflammation and injury in dysplastic joints (Palmoski, 1979). However, controlled nonconcussive exercise, such as swimming, is beneficial in maintaining cartilage nutrition, range of joint motion, muscle strength, and cardiovascular function. Surgical management Surgical intervention is currently advocated by many surgeons who argue that progression of clinical dysplastic disease is inevitable with conservative management and that early operative treatment is required to return the joint to normal weight-bearing forces and prevent osteoarthritic changes (Schrader, 1982; Slocum and Devine, 1987; Slocum and Devine, 1990).

Surgical Treatment

It includes pectineal myectomy, lengthening of the femoral neck, intertrochanteric osteotomy, and triple pelvic osteotomy. Technique selection is influenced by the function and age of the animal, financial considerations, preference of the surgeon,

the degree of osteoarthrosis present, and the conformation of the femur and acetabulum.

Pectineal myectomy has been advocated as a palliative procedure in the treatment of hip dysplasia (Wallace, 1992). Release of the pectineus muscle decreases the upward force impacting the femoral head into the acetabulum, thereby releasing tension on the joint capsule, decreasing muscle tension and pain, and allowing better coverage of the femoral head within the acetabulum. As the procedure does not improve joint stability, osteoarthritic changes still occur and pain relief is temporary (Bowen, 1972). There is evidence to suggest that pectineal myectomy may actually worsen the severity of osteoarthrosis (Cardinet, 1974). While some surgeons argue that recurrence of clinical signs following pectineal myectomy is unpredictable and that surgery may temporarily alleviate pain, most surgeons no longer recommend pectineal myectomy for treatment of hip dysplasia (Wallace, 1992).

Lengthening of the femoral neck is used to redirect and seat the femoral head into the acetabulum (Smith, 1992; Devine and Slocum, 1995). Dogs with hip dysplasia tend to have shortened femoral necks that permit lateral movement of the femoral head and subsequent subluxation. This procedure is viewed with caution by some veterinary surgeons, as complications, such as femoral fractures, may occur and long-term scientific studies of its efficacy are lacking (Smith, 1992; Devine and Slocum, 1995).

Corrective osteotomies used in the treatment of hip dysplasia include intertrochanteric and triple pelvic osteotomy (Schrader, 1982; Slocum and Devine, 1987; Slocum and Devine, 1990; Hohn and Janes, 1969; Schrader, 1986; Slocum and Devine, 1986; Braden, 1990; Walker and Prieur, 1987). The goals of both procedures are to re-establish joint congruency, maintain the range of hip motion, increase the weight-bearing forces, and prevent the development of degenerative joint disease. Candidates for these surgeries are dogs that have clinical signs of lameness, are subluxated, and do not have radiographic signs of osteoarthrosis. Corrective osteotomies are also recommended in young dogs less than 1 y of age, although dogs at 1 y of age, with minimal radiographic changes, may still be surgical candidates.

Intertrochanteric osteotomy improves the biomechanics of the dysplastic hip by centering the femoral head within the acetabulum (Braden, 1990; Walker and Prieur, 1987). Although not consistent in all affected dogs, some dysplastic dogs have increased angles of femoral neck inclination (>1460+50) and anteversion (>270+6.50) that tend to increase coxofemoral subluxation (Prieur, 1980; Hauptman, *et al.*, 1985). The surgery involves changing the position of the femoral head and neck, relative to the acetabulum, in 3 planes. In the 1st plane, the inclination of the femoral neck is made more perpendicular to the femoral shaft, changing it from a valgus to a varus position. Secondly, the anteversion of the femoral head and neck is reduced and rotated to a normal angle.

In the 3rd plane, the femoral head, neck, and greater trochanter are shifted medially relative to the shaft of the femur, thereby effectively lengthening the femoral neck. The procedure involves a precise wedge osteotomy of the femur just proximal to the lesser trochanter. After removal of the bone wedge, the femur is reduced in the 3 planes, and fixed with a double hook plate and screws.

Retrospective clinical studies have reported similar success rates in dogs undergoing this procedure (Braden, 1990; Walker and Prieur, 1987; Braden, 1994). Overall, 84% to 89% of dogs were functionally good or excellent at follow-up from 15 mo to 3 y after surgery. Of 100 hips that were operated on, only 3 required subsequent total hip replacement to alleviate clinical signs of pain associated with progressive osteoarthrosis.

Triple pelvic osteotomy was first described by 1969 (Hohn and Janes, 1969). To decrease postoperative complications and for technical ease, the modified technique described by Slocum is presently advocated (Slocum and Devine, 1987; Slocum and Devine, 1990; Slocum and Devine, 1986). The procedure involves a transverse osteotomy of the ilium, together with ischial and pubic osteotomies. The acetabular segment is then rotated, according to predetermined angles of reduction and subluxation, to increase coverage of the

femoral head.

The morbidity after unilateral and bilateral DPO was lower than after TPO because elimination of the ischiatic osteotomy allowed for increased stability of the pelvis. The surgical technique of DPO was a little more demanding than TPO because of the difficulty in handling and rotating the acetabular iliac segment, but this difficulty was offset by elimination of ischial osteotomy (Vezzoni *et al.*, 2010).

Changes in hip joint congruity was evaluated in dogs with hip dysplasia before and after triple pelvic osteotomy by computed tomography examination in the standing position. Lateral center edge angle significantly increased, and centre distance (CD) significantly decreased after surgery compared to the values before surgery, respectively. There was an inverse proportion between the postoperative period and the change in the ratio of CD. These results suggested that joint laxity was improved with time after surgery, providing evidence of the clinical usefulness of this surgery (Hara *et al.*, 2002).

The ilial osteotomy is then stabilized with a pelvic osteotomy plate. Using the modified approach, reported complications include implant failure (13% to 36%), incisional problems (14%), acetabular fracture (12%), and transient sciatic neuropraxia (3%) (Slocum and Devine, 1987, Slocum and Devine, 1986, Remedios and Fries, 1993; Koch, *et al.*, 1983; Hosgood and Lewis, 1993). Pelvic canal narrowing is also considered a significant complication of triple pelvic osteotomy (Graehler *et al.*, 1994; Sukhiani, *et al.*, 1994). Short-term success of triple pelvic osteotomy has been good, with resolution of clinical lameness and minimal progression of joint disease in 86% to 92% of cases up to 1 y after surgery (Slocum and Devine, 1987).

Force plate analysis has indicated that loads transmitted through dysplastic hips after triple pelvic osteotomies increased after the operation and were greater than in untreated limbs (44). Although longterm scientific evaluation of the Slocum procedure has not been reported in the veterinary literature, most surgeons currently recommend this surgery as the procedure of choice in lame dysplastic young dogs with no or minimal osteoarthrosis.

Treatment in Dogs with Moderate to Severe Osteoarthrosis

Although conservative management may be effective in many dysplastic dogs with moderate osteoarthrosis, the degree of coxofemoral incongruency and the severity of osteoarthritic changes in some dogs may preclude alleviation of pain by conservative means. Dysplastic dogs affected with moderate or severe coxofemoral osteoarthrosis that are nonresponsive to conservative management are candidates for surgical treatment. Salvage surgeries, such as biocompatible osteoconductive polymer (BOP)/shelf arthroplasty, femoral head excision arthroplasty with or without muscle slings, and total hip replacement, have been proposed in these animals (Sertl and Jensen, 1990; Jensen and Sertl, 1992; Olmstead, *et al.*, 1981; Olmstead, *et al.*, 1983).

The shelf arthroplasty uses a BOP to extend the dorsal rim of the dysplastic acetabulum and prevent subluxation (Sertl and Jensen, 1990; Jensen and Sertl, 1992). The goal of this procedure is not to cure hip dysplasia, but to slow the progression of osteoarthrosis. Candidates for shelf arthroplasty are animals with subluxation or luxation, and moderate to advanced osteoarthrosis. Advantages of this procedure include a short operative time, a relatively simple surgical technique, minimal metallic implants, bilateral surgeries performed during the same anesthetic period, and rapid return to function. Complications associated with the shelf arthroplasty include seroma formation, sciatic neuropraxia, screw breakage, infection, and chronic draining tracts. The BOP fibers are seated in the ilium just dorsal to the acetabular rim. A BOP block is screwed onto the lateral surface of the ilium, immediately dorsal to the implanted fibers. Biocompatible osteoconductive polymer is an osteoconductive polymer, and its fibers should allow for the potential ingrowth of new bone. However, current studies indicate that BOP does not promote osteoconduction and its use is not warranted (Olmstead, *et al.*, 1981; Olmstead, *et al.*, 1983; Oakes, *et al.*, 1983). In addition, there are no

short- or longterm scientific studies documenting the effectiveness of BOP/shelf arthroplasty in the treatment of canine hip dysplasia. Femoral head and neck excision is probably the most common salvage procedure performed for debilitating hip dysplasia in clinical small animal practice. The goals of excision arthroplasty are alleviation of pain and restoration of limb function (Berzon, *et al.,* 1980; Duff and Campbell, 1977; Rettenmaier and Constantinescu, 1991). Clinical results of excision arthroplasty vary with body weight; unsatisfactory outcomes have been reported in dogs weighing over 20 kg (Duff and Campbell, 1977). Thirty percent of owners of 267 dogs that had excisional arthroplasties reported continued postoperative mechanical lameness (Duff and Campbell, 1977).

Poor outcome in large dogs is thought to be a result of a larger muscle mass forcing the proximal femur into contact with the acetabulum. Bone-to-bone contact causes pain in the early postoperative period, resulting in decreased limb usage and slow return to function (Berzon, *et al.,* 1980; Duff and Campbell, 1977). Over time, postoperative function in large dogs is not limited by pain, but by mechanical factors including restrictive pseudoarthrosis, decreased range of coxofemoral motion, shortening of the limbs that were operated on, and atrophy of the thigh muscles. Despite the fact that it gives rise to an abnormal postoperative gait, femoral head and neck excision is still a viable treatment of hip dysplasia because of its technical ease, relatively low surgical costs, and effective relief of pain. Owners, however, have to be aware of the limited athletic ability of their pet after it undergoes a femoral head and neck excision.

To prevent bone-to-bone contact and improve postoperative function, muscle slings, based on the deep gluteal, rectus femoris, and biceps femoris muscles, have been developed as interpositional cushions at ostectomy sites (Berzon, *et al.,* 1980; Lippincott, 1984). The use and benefits of adjunctive soft tissue interpostion following femoral head and neck excision is, however, controversial in veterinary surgery. Although good clinical results have been reported, particularly using the biceps femoris muscle sling, other studies have failed to show an improvement in function and have demonstrated increased postoperative complications (Lippincott, 1984).

Postoperative effects of adjunctive muscle slings, including thigh muscle atrophy, and decreased ranges of hip motion, standing hip angles, and limb lengths, are similar to those of standard femoral head and neck excision. Complications, such as pyrexia, extensive pitting edema, and wound infection, have been reported with the biceps femoris muscle sling. Most studies indicate that use of a muscle sling does not have any benefits over the standard technique of femoral head and neck excision in large dogs.

Total hip replacement is a well-established procedure for treating coxofemoral osteoarthrosis in large dysplastic dogs (Olmstead, *et al.,* 1981; Olmstead, *et al.,* 1983). Dogs undergoing hip replacement must be at least 9 mo of age and weigh over 15 kg, with no upper age or weight limits. The candidate should also be in excellent health without infection anywhere in the body (cystitis or gingivitis), concurrent neurologic disease (degenerative myelopathy, lumbosacral disease), or concurrent orthopedic disease (rupture of the cranial cruciate ligament). Total hip arthroplasty can involve cemented or cementless prostheses (Olmstead, *et al.,* 1981; Olmstead, *et al.,* 1983).

Presently, due to the cost and lack of availability of customized cementless total hip components, cemented arthroplasty is most commonly performed in dogs. The surgery involves replacement of the dysplastic acetabulum with a high density polyethylene cup that is secured in place with polymethylmethacrylate cement. The femoral head and neck are replaced with stainless steel femoral head and shaft components. Although hip dysplasia commonly affects both hips, approximately 80% of dogs require only unilateral replacement; the body weight is shifted to the replaced hip, relieving pain on the unoperated side. A functional success rate of 95%, with good to excellent results, has been reported (Olmstead, *et al.,* 1981; Olmstead, *et al.,* 1983).

Although comparative studies between total hip replacement and standard femoral head and neck excision have not been done, most veterinary surgeons recommend hip replacement as the best available treatment for coxofemoral osteoarthrosis

in large dysplastic dogs. Relative limb use, range of motion, and overall limb function following total hip replacement exceed those reported for dogs of similar size following use of any femoral head and neck excision technique. Complications associated with total hip arthroplasty include infection (1% to 5%), dislocation (5%), noninfected component loosening (6%), fractures (2%), and sciatic neuropraxia (2%). Treatment of these complications is, however, successful in 60% of affected cases. The treatment approach for canine hip dysplasia depends primarily on the degree of coxofemoral osteoarthrosis. In young animals, without radiographic evidence of degenerative hip changes, treatment options include conservative and medical management, pectineal myectomy, lengthening of the femoral neck, and corrective osteotomies. In dysplastic animals with advanced osteoarthrosis, conservative and medical management are often ineffective, and surgical salvage procedures, such as BOP/shelf arthroplasty, femoral head and neck excision, and total hip arthroplasty, are performed. Final selection of treatment is based upon the general health and function of the animal, owner demands, and financial considerations.

Weight management is an effective and important component of managing dogs with HD and associated osteoarthritis. Techniques that modulate the progression of joint disease may also be beneficial for treating dogs with HD. Further studies are needed to investigate other methods of managing HD such as hydrotherapy and physical rehabilitation (Kirkby & Lewis, 2011).

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