A PILOT CONTROLLED TRIAL TO DETERMINE THE EFFECTIVENESS OF INSTRUMENT MANIPULATION IN THE MANAGEMENT OF SYMPTOMATIC CANINE HIP DYSPLASIA

BY

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I, Tamara Meuwese do declare that this dissertation is representative of my own work.

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DEDICATION

This dissertation is dedicated to my parents, Frans and Joan, for their constant support throughout my student career, to my husband, Hayden, for his patience and understanding, for the duration of this undertaking, and to Steve, without whom, this would not have been possible.

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ABSTRACT

The paucity of clinical research into the cause of canine hip dysplasia, efficacy and effects of the different treatment protocols available for the management of symptoms, as well as the differing presentations, has led to a continued variation in standardized care for this condition.

The aim of this study was to contribute further information on the use of instrument manipulation as an alternative or adjunctive means of managing the symptoms of canine hip dysplasia. Both manual and instrument manipulation have effectively been used in the short-term management of human musculoskeletal pconditions, it was hypothesized that the use of instrument manipulation would benefit the canine patient. The use of human based studies was a guideline, as no previous chiropractic studies have been conducted on the canine subject.

The study design chosen was that of a pilot controlled clinical trial. Thirty canines diagnosed with hip dysplasia were randomly assigned into two groups. The treatment group received instrument manipulation, via an adjusting instrument, at the appropriate levels, determined by means of motion palpation. These canines also received glucosamine sulphate supplementation. The control group, were administered glucosamine sulphate only. Each canine received 500mg/10kg bodyweight of glucosamine sulphate supplementation daily, for the period of one month. Each group received five consultations within this one month period as follows, two consultations a week for the first two-weeks, with a two-week follow-up visit.

Objective data was assimilated from motion palpation findings, orthopedics tests, goniometer readings, hind leg circumference, and hind-feet tarsal diameter measurements. A veterinarian approved canine hip dysplasia disability index form was used to collect the subjective data.1

Data were captured in MS Excel and imported into SPSS version 12.0 (Chicago, Ill) and STATA version 8 (STATA corp. Texas, USA) for analysis.

Quantitative variables were checked for normality and if normally distributed, parametric statistical methods were used to describe and compare groups. Non parametric Mann-Whitney tests were used to compare independent groups with skewed data. Repeated measures ANOVA was used to analyze normally distributed quantitative variables for the main effects of time and group, as well as a time by group interaction.

Categorical variables (independent groups) were analyzed bivariately using Pearson's chi square and over time (5 visits- paired groups) using generalized estimating equations in STATA for the effect of the intervention.

Hypothesis testing rule: a two-sided p value of <0.05 was considered as statistically significant.

For the orthopedic tests for lumbar extension and possibly wheelbarrow, the treatment had a significant protective effect (a definite decrease in positive pain responses). Goniometer readings did not differ significantly between the groups over time, except in the case of right hind leg abduction, where the treated group increased significantly faster than the control group. Right side thigh measurements increased over time to a greater extent than left side thigh measurements, regardless of treatment group of the dog. Tarsal diameter did not change significantly over time or between the groups. Both groups showed a significant decrease over time with regard to the total disability index score, but there was no difference in this change over time between the groups. Of the individual questions, only reaction to cold weather showed a faster decrease in treated dogs than in control dogs. The majority of the questions remained unchanged over time in both groups or changed at the same rate in both groups. Thus there is no overwhelming evidence that the intervention is superior to the control except in two of the orthopedic tests. Dogs in both groups seemed to improve to the same extent over time.

It is recommended that this study be repeated with a larger sample population, so that a more accurate conclusion can be drawn from the derived results. A follow-up study at six months, one year and two years might help establish how effective the intervention is over a longer period.

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CHAPTER ONE

INTRODUCTION

1. INTRODUCTION

Animal chiropractic is a relatively new field although it is believed that D.D. Palmer, the founder of the chiropractic profession, adjusted animals around the turn of the twentieth century (Kamen, 1996). Currently however, there is limited information available to justify the use of manipulative therapy in the management of symptomatic canine hip dysplasia and other degenerative conditions.

This pilot controlled trial, aims to contribute further information on the use of manipulation[1] as a means of managing the symptoms of canine hip dysplasia.

Canines with hip dysplasia compensate for their loss of hip stability, and pain during weight bearing, by shifting balance. This biomechanical disturbance results in aberrant spinal loading, joint subluxation[2] and muscle spasm. These factors cause a subsequent decrease in rear-end mobility, which further compounds the loading of the affected hip, thus accelerating the disease process (Bojrab, 1997).

This trial was designed to determine whether instrument manipulation would benefit canines diagnosed with hip dysplasia, in terms of managing their symptoms. By means of stimulating the nervous system in such a way, that it would allow the body to in fact manage the symptoms such as pain, using glucosamine sulphate as a control.

[1]Manipulation – "Passive maneuver in which specifically directed manual forces are applied to vertebral and extravertebral articulations of the body, with the object of restoring mobility to restricted areas" (Gatterman, 1990). Williams and Wilkins, Baltimore, USA.

2.Subluxation – refers to a motion segment (2 adjoining vertebral bodies and their connecting soft tissue) (Leach, 1994) in which there is "a functional defect or alteration of the biomechanical and physiological dynamics in a joint, which may cause neuronal disturbances" (Inman, 1996).

The conventional first-line of treatment by allopathic physicians for the treatment of musculoskeletal conditions is often nonsteroidal anti-inflammatory drugs, whereas the first line of treatment of chiropractic physicians is usually manipulation (Dabbs and Lauretti, 1995). Both manual and instrument manipulation have effectively been used in the short-term treatment of human subjects (Gatterman, 1990). The use of human based studies was used as a guideline, as no previous studies have been conducted on the canine subject. This trial therefore, aims to investigate the efficacy of instrument manipulation in canines.

The adjusting instrument designed by Fuhr and Lee in 1960's is a hand held device, which delivers a controlled and reproducible force, applied at a specific line of drive at high speed (Fuhr et al, 1997).
This device has since been used in numerous trials and studies and has been proven effective.

The device itself consists of a spring-loaded rubber tip, which when released, fires at a rate of 2-4 milliseconds. This works on the principles of Newton's 2^{nd} law (FORCE = MASS X ACCELERATION). With the acceleration increased, the mass can be decreased, to a point where no tissue damage will occur, but will still deliver a force suitable to reduce a subluxation, and trigger normal reflex responses.

This is of benefit in that it allows the practitioner to deliver sufficient force using, a small mass. It enables the practitioner to direct that force in the appropriate direction (called line of drive). And it ensures that the force is delivered before the dog can offer resistance to that force, due to fact that the instrument fires at a rate faster than that of the canines' reflex time (Inman, 1996).

The evidence for the efficacy of spinal manipulation by means of an adjusting instrument is presented, in chapter two, but both instrument and manual adjusting techniques have been shown to be effective at reducing pain and disability in humans (Wood et al, 2001).

The device works by means of stimulating the mechanoreceptors and proprioceptors within a motion segment (i.e. 2 adjacent vertebral bodies). These receptors fire impulses to the brain at a rate faster than pain fibers. Blocking the impulses from the pain receptors results in reflex relaxation of the muscles within that motion segment. This, along with the force delivered by the instrument allows for the restoration of normal motion to the joint (Inman, 1996).

Glucosamine sulphate, as a nutritional joint supplement, and its safety and uses are also discussed in chapter two. Postulated pharmacological actions include direct action of glucosamine sulphate on cartilage. It is hypothesized that glucosamine sulphate rebuilds damaged cartilage (Drovanti, 1980). Ruane and Griffiths (2002) compared the use of glucosamine sulphate to ibuprofen for joint pain, and results showed the two to be of similar efficacy. It was therefore concluded that glucosamine sulphate is as effective at relieving joint pain as ibuprofen, but with fewer side effects.

Even though NSAIDS are widely used and considered safe, there are serious risks of complications (Gottliebe, 1997). In a study by Willcox et al, (1994) there was a significant association with the use of NSAIDS and upper gastrointestinal bleeding, in human subjects. As reported by Lambrechts (1999) the side effects of gastrointestinal and kidney damage, and the weakening of cartilage, occur in the canine.

According to Huskisson et al, (1995) long-term NSAID use (Indomethacin for the period of one year) increases the rate of radiological changes in osteoarthritic knees, by causing further cartilage damage, which results in joint space narrowing. One can assume that certain anti-inflammatory drugs have detrimental effects on joint cartilage. In a review by Gottliebe (1997), of current literature investigating the most commonly used treatments of osteoarthritis, anti-inflammatory drugs were shown to have a deleterious effect on cartilage by means of inhibiting proteoglycan synthesis. Gottliebe (1997) also describes what has been called analgesic arthropathy - long-term use of NSAIDS resulting in rapid joint deterioration, due to a loss of protective pain sensation, or the direct effect of the drug on the cartilage. As reported by Lambrechts (1999) side effects of gastrointestinal and kidney damage, as well as weakening of cartilage, occur in the canine with long- term NSAID use.

More recently a review of several studies using glucosamine sulphate, have shown this nutritional supplement as a safe, effective and natural alternative to NSAIDS for the symptoms of inflammatory joint conditions (Gottlieb, 1997). In a conference at the National Institutes of Health, Hochberg et al (2000) stated that glucosamine has been used for many years in veterinary medicine to treat the symptoms of arthritic conditions. Hochberg et al (2000) also state that glucosamine is a naturally occurring compound within the body and may be involved in the repair and maintenance of normal cartilage.

In a study by Reginster et al (2001) the long-term effects of glucosamine sulphate were addressed and significant improvements in both pain and physical function were noted when compared with placebo. There were also no substantial differences noted in terms of side effects noted between glucosamine and placebo over the three years, with most of the adverse effects being transient and mild to moderate in nature (Reginster et al, 2001). Noack et al (1994) concluded that glucosamine sulphate might be a safe and effective symptomatic slow acting drug for ostearthritis. It is for the above reasons that glucosamine sulphate was chosen as the control for this study.

Data were captured in MS Excel and imported into SPSS version 12.0 (Chicago, Ill) and STATA version 8 (STATA corp. Texas, USA) for analysis.

Quantitative variables were checked for normality and if normally distributed, parametric statistical methods were used to describe and compare groups. Non parametric Mann-Whitney tests were used to compare independent groups with skewed data. Repeated measures ANOVA was used to analyze normally distributed quantitative variables for the main effects of time and group, as well as a time by group interaction.

Categorical variables (independent groups) were analyzed bivariately using Pearson's chi square and over time (5 visits - paired groups) using generalized estimating equations in STATA for the effect of the intervention.

Hypothesis testing rule: a two-sided p value of <0.05 was considered as statistically significant.

The aim of this study is to determine the effectiveness of instrument manipulation, in terms of subjective and objective clinical findings in the management of symptomatic canine hip dysplasia, using glucosamine supplementation as a control.

The information obtained and deductions made from the outcome of this study may help to identify an additional or more effective treatment protocol for the management of this condition.

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

2. REVIEW OF THE RELATED LITERATURE

2.1 INTRODUCTION

This chapter provides a comprehensive overview of the relevant available literature on canine hip dysplasia, as well as the current trends of both management and treatment of this condition.

The evidence for the efficacy of spinal manipulation by means of an adjusting instrument is presented.

Glucosamine sulphates use as a nutritional joint supplement and its safety are discussed.

2.2 ANATOMY OF THE CANINE HIP JOINT

<u>Gross anatomy of the canine hip:</u>

It is important to have an understanding of the anatomy of the canine hip joint in order to understand the pathophysiological changes that occur within canine hip dysplasia.

The hip joint is a synovial joint with hyaline articular cartilage, a joint capsule and a synovial lining (Moore, 1992). This freely moveable joint connects the skeleton of the lower limb to the vertebral column.

The hipbone consists of a large irregularly shaped bone, formed by the fusion of three bones the ilium, ischium and pubis. These are arranged in such a way that they form a cup-shaped socket, the acetabulum, on the lateral aspect for articulation with the head of the femur (Moore, 1992). The head of the femur, covered by hyaline cartilage, fits into this articulation to form the hip joint.

There is a deep notch located medially for the attachment of the interosseous round ligament (Sisson and Grossman, 1953). This ligament is comprised of a short, strong band that attaches to the subpubic groove close to the acetabular notch, which then passes outward, and ends in the notch located on the femoral head. The importance of this ligament in the canine species is that it is often small and sometimes absent, which allows for increased abduction (Sisson and Grossman, 1975).

The femoral head fits into the acetabulum in such a way that rotation takes place around three different axes, with the greatest range of motion being displayed in flexion and extension (Sisson and Grossman, 1975). The canine hip joint is unusual in that it allows for a fourth degree of freedom, in which the head is displaced laterally from the acetabulum (Cargill and Thorpe- Vargas, accessed 13 March 2001).

This allows for a far greater range of motion, but also creates problems, when there is too much laxity within the joint, resulting in increased joint stress during weight bearing and a change in joint mechanics (Cargill and Thorpe- Vargas, accessed 13 March 2001).

Articular Cartilage: cartilage is a semi rigid supportive connective tissue, comprised of a proteoglycan molecular ground substance containing collagen, elastic fibers and chondrocytes (Burkitt et al, 1993). In the adult skeleton, cartilage thickness is determined by the ability of diffusion, as normal mature hyaline cartilage is avascular and aneural (Moore, 1992). Viability of the innermost cells is dependent on the dissolving of nutrients and waste through the ground substance of synovial fluid covering its free surfaces (Burkitt et al, 1993).

Healthy adult articular cartilage is smooth and thick, and cell differentiation in the periphery is suspended unless growth is stimulated (Burkitt et al, 1993). However, age, decreased nourishment, and abnormal wear and tear results in thinning or splitting.

The function of articular cartilage is to transmit loads and allow for repetitive joint motion without breaking down (Burkitt et al, 1993). Thus cartilage has the ability to deform under load. Its thickness at the center, where the weight bearing pressure is greatest, helps spread the force over a larger surface area. It therefore stands to reason that any factor compromising the normal biomechanics of the hip joint, with the resulting abnormal displacement of load will lead to degenerative changes.

Joint Capsule: the two-part structure consisting of a fibrous capsule and synovial membrane, which envelops the joint (Moore, 1992). The synovial membrane, which has the ability to regenerate if damaged, covers the joint surface with the exception of the articular cartilage, leaving this free cartilaginous surface exposed to friction (Burkitt et al, 1993).

Muscle Attachments: Muscular attachments over the lateral aspect of the hip joint as described by Sisson and Grossman (1975) include the following: gluteus superfiscialis, a small muscle arising from the gluteal fascia, lateral aspect of the sacrum, first coccygeal vertebra and sacro-sciatic ligament. It inserts behind and below the trochanteric major of the femur. The gluteus medius originates on the sacrum and inserts into the trochanteric major via a strong tendon. The gluteus profundus, which is broad and fan-shaped, arises from the superior ischiatic spine and ilium and inserts into the trochanter major. Piriformis originates from the sacrum and inserts close to gluteus medius, on the trochanter major.

Muscles located medially to the hip joint are: pectinues, which arises from the ilio-pectineal eminence and inserts into the linea aspera at the distal femur. The large adductor femoris, originates from the ventral portion of the pubis and ischium, and ends on the linea aspera of the femur (Sisson and Grossman, 1975).

These muscles, especially pectineus, limit abduction (Bojrab, 1997). As described by Bojrab (1997), when abduction occurs, these muscles are lengthened by the lateral displacement of the femoral head. This then exerts extra forces on an already inflamed and stretched joint capsule, which results in pain (Bojrab, 1997).

As described by Bojrab (1997), with hip dysplasia, the change in slope of the acetabulum results in the femoral head continually luxating laterally. The canine has two means of reducing this lateral displacement. One consists of constant contraction of the hip abductor and rotator muscles until fatigue. The second means, is for the canine to walk with a wide distance between the two hind feet, referred to as an increase in base-width. Axial muscle forces are then redirected into the acetabulum, which allows for relaxation of the abductor muscles.

Innervation: The hip joint receives its supply of proprioceptive innervation via the lumbo-sacral plexus, which consists of ventral branches of the last five lumbar and first sacral nerves (Sisson and Grossman, 1975).

2.3 HIP DYSPLASIA

2.3.1 DEFINITION

Hip dysplasia as defined by Kirberger (1999) is a "developmental, multifactorial, genetically influenced condition that is characterized by ill-fitting or loosely-fitting hip joints and the development of secondary degenerative joint disease (arthrosis)."

2.3.2 INCIDENCE AND PREVALENCE OF HIP DYSPLASIA

In some breeds of canines, it is considered to be the most common cause of osteoarthritis or degenerative joint disease of the hip (Moore, accessed 15 May 2002).

According to Kirberger (1999) hip dysplasia is one of the most common orthopeadic problems to affect larger dogs, with a prevalence of up to forty-three percent. Breeds most at risk for hip dysplasia include; Bulldogs, St. Bernards, Golden Retrievers, Rottweilers, German Shepherd Dogs and Labradors (Kirberger, 1999).

Willis (1999) believes that hip dysplasia is more likely to occur among heavier rather than lighter breeds and is a relatively common finding in larger, working dogs.

2.3.3 AETIOLOGY

As defined by Bojrab et al (1997) hip dysplasia is an inherited condition of the hip, with various anatomical differences providing biomechanical prerequisites for degeneration of the hip joint. Kirberger (1999) states that “genetically susceptible dogs become dysplastic when the primary muscles supporting the joints mature at varying rates to the skeletal structures” this causes a loss of congruency between soft tissue strength and biomechanical forces, which results in joint laxity and degeneration.

Canines with hip dysplasia compensate for their loss of hip stability and pain during weight bearing, by shifting balance. This biomechanical disturbance results in aberrant spinal loading, joint subluxation and muscle spasm. These factors cause a subsequent decrease in rear-end mobility, which further compounds the loading of the affected hip, thus accelerating the disease process (Bojrab, 1997).

As described by Cargill and Thorpe-Vargas, (accessed 13 March 2001) hip dysplasia is a genetically transmitted disease, with heritability adding a complicating factor. In other words, genetics is the cause, but environment plays a role in the expression of the genetics

In conclusion, hip dysplasia is not something which a dog acquires, it is either genetically dysplastic or not (Cargill and Thorpe- Vargas, accessed, 13March 2001).

2.3.4 OSTEOARTHRITIC CHANGE ASSOCIATED WITH CANINE HIP DYSPLASIA

Osteoarthritis as defined by Burkitt et al (1996) is "a degenerative disorder of articular cartilage believed to occur as a result of excessive wear and tear although there may be secondary inflammatory changes in the soft tissue components of the joint." Burkitt et al (1996) go on to describe this degeneration as loss of the smooth appearance of the articular cartilage, erosion of the cartilage until the underlying bone is exposed, and the thickening and hardening of this exposed bone.

The bone becomes dense and appears highly polished referred to as eburnation. Osteophytic new bone is layed down at the articular margins and cystic degeneration of the bone may occur. All these changes result in progressive limitation of joint range of motion, pain, and the characteristic radiographic findings (Burkitt et al, 1996).

Bojrab (1997) explains the mechanism of these osteoarthritic changes, as the result of the acetabulum being too shallow. The joint capsule then becomes stretched, or the cartilaginous labrum becomes fractured. Muscle forces are then relied on to provide stability. When these muscles fatigue, the joint capsule stretches and the dorsal acetabular rim (DAR) is damaged, resulting eventual osteoarthritic changes which are evident on radiograph (Bojrab, 1997:1145).

2.3.5 EVIDENCE AND CLINICAL FEATURES OF HIP DYSPLASIA

Cargill and Thorpe-Vargas (accessed, 13March 2001) state that canine hip dysplasia is a genetically predetermined disease, but phenotypes can range from normal to severely dysplastic and functionally crippled.

As described by Bojrab (1997) the signs and symptoms of canine hip dysplasia first present around the age of two years, in the majority of canines. However, if severe enough this condition can be diagnosed as early as six months.

Signs and symptoms include (Bojrab, 1997:1152):

- musculoskeletal tenderness
- lameness
- joint crepitus
- restriction in range of motion
- muscle atrophy

The following secondary manifestations could also occur (Bojrab, 1997:1152):

- capsular laxity of the hip joint
- osteophytic formation
- destruction of the dorsal acetabular rim
- ligament hypertrophy
- ligament degeneration

2.3.6 DIAGNOSTIC CRITERIA OF HIP DYSPLASIA

Evaluation of the canine hip for hip dysplasia involves gathering information on the history and attitude of the dog from the owner, performing a series of hip function assessment tests on the awake and anesthetized dog, and obtaining a three-dimensional view of the hip joint by radiographs (Bojrab, 1997:1145).

Assessment tests used in the diagnosis of hip dysplasia include:

- the hip subluxation test
- Ortolani sign
- Barlow sign

Hip subluxation test:

A primary means of demonstrating that soreness and/or lameness is due to hip pathology. This tests specificity for hip dysplasia is due to the dog's response to pain from the inflamed joint capsule.

The attachment of the joint capsule at the dorsal acetabular rim (DAR) is stressed as the examiner pulls laterally on the hip. The canine then contracts the thigh musculature in anticipation of pain, which causes the hip to translate dorsally into the inflamed capsule, resulting in a positive response (Bojrab, 1997).

Ortolani Sign:

Originally used in human medicine to indicate hip dysplasia, the hip is moved from a starting position of adduction, with no flexion or extension. The hip luxates from the acetabulum in this position. The hip is then slowly abducted a "clunk" as the hip relocates indicates a positive sign (Bojrab, 1997:1143).

Barlow Sign:

A dislocation test used in human medicine, as opposed to the Ortolani relocation test, indicates hip dysplasia, when abducted hip is slowly adducted. A positive sign is indicated by palpation of a "shift" of the femoral head.

The diagnosis of hip dysplasia is tentatively made after the dog has shown clinical signs of the condition and has a positive result for some of the above-mentioned physical tests. However a definitive diagnosis can only be made after radiographic examination of the hip joints.

It is important to note that presentation of this condition varies widely, but upon clinical examination findings may include one or more of the following: lameness in the hindquarters, which is usually exacerbated by exercise, difficulty in getting up, running and stair climbing, and occasionally bunny-hopping (Kirberger, 1999).

Early clinical signs, in young dogs as early as six months, are usually as a result of joint laxity. These signs may improve or even go unnoticed, until the dog develops arthritic changes within the hip joint due to degenerative joint disease. This often presents with muscle wasting, a waddling gait, hindquarter weakness, and reluctance to exercise (Kirberger, 1999).

2.3.7 RADIOGRAPHIC EVIDENCE OF HIP DYSPLASIA

Clinically six radiographic views are used when assessing canine hip dysplasia: ventrodorsal, lateral, DAR, frog, compressed ventrodorsal, and distracted ventrodorsal views (Bojrab, 1997:1148). The ventrodorsal view is the most commonly used and shows the position of the femoral head within acetabulum (Bojrab, 1997:1148). In the normal hip, congruence between the subchondral bone of the femoral head and cranial acetabulum can be seen (Bojrab, 1997:1148).

The canines are heavily sedated, or put under general anaesthesia in order to obtain good radiographs (Kirberger, 1999).

According to Kirberger (1999) in severe cases of hip dysplasia, confirmatory changes can be seen as early as six months, but routine radiographic examination is usually delayed until skeletal maturity is reached.

2.3.8 SECONDARY MANIFESTATIONS OF HIP DYSPLASIA

These include: capsular laxity of the hip joint, tearing of the joint capsule, an increase of synovial fluid, acetabular osteophytes, femoral osteophytes, a loss of acetabular joint space, destruction of the dorsal acetabular rim, ligament hypertrophy or degeneration, and articular cartilage fibrillation[1] or eburnation[2] (Bojrab, 1997: 1152).

As described by Kirkaldy-Willis (1992) these changes that occur, include: synovitis in the early stages, degeneration of articular cartilage, with severity ranging from minimal to marked, intra- articular adhesions, capsular laxity, allowing joint subluxation, and eventual formation of subperiosteal osteophytes.
The end result is a joint, which has grossly degenerated with loss of articular cartilage, intra articular osteophytes and loss of joint space. It is these osteoarthritic changes which cause the canine discomfort

2.3.9 CONVENTIONAL TREATMENT OF HIP DYSPLASIA

Based on their anti- inflammatory and analgesic properties, Non-steroidal anti-inflammatory drugs (NSAIDS) are one of the most commonly prescribed medications (van Tulder et al, 2000). It is the inhibition of prostaglandin synthesis, which helps to alleviate pain and inflammation (Gottlieb, 1997). These

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[1] Recurrent, involuntary, and abnormal muscular contraction in which a single or small number of fibers act separately rather than a coordinated unit, Dictionary of Medical Terms. 3rd ed. 1994. Barron's Educational Series, Inc.
[2] Diseased condition in which bone or cartilage becomes hard and dense like ivory, Merriam Webster's Medical Desk Dictionary. 1993. Merriam-Webster In. , Springfield , Massachusetts, U.S.A.

drugs however, are aimed at relieving the symptoms and not the progression of osteoarthritic conditions (Gottlieb, 1997).

In a review of 51 studies by van Tulder et al (2000) to determine the effectiveness of nonsteroidal anti-inflammatory drugs for the treatment of low back pain in humans. Results show only a small statistical improvement when compared with a placebo, and moderate evidence between the efficacy of nonsteroidals and spinal manipulation.

Even though NSAIDS are widely used and considered safe, there are serious risks of complications (Gottlieb, 1997). In a study by Willcox, et al (1994) there was a significant association with the use of NSAIDS and upper gastrointestinal bleeding in humans. As reported by Lambrechts (1999) the side effects of gastrointestinal and kidney damage, and the weakening of cartilage, occur in the canine with long-term use.

According to Huskisson et al (1995) long-term NSAID use (Indomethacin for the period of one year) increases the rate of radiological changes in osteoarthritic knees. One can assume that certain anti-inflammatory drugs have detrimental effects on joint cartilage. Gottlieb (1997) agrees with this, stating that analgesic arthropathy, the degeneration of cartilage with the long-term use of NSAIDS, is thought to be due to a loss of protective pain sensation, but is more likely due to the direct effect of the drug on the cartilage.

2.4 SUBLUXATION COMPLEX

The word "subluxation" means different things to different healthcare professionals. To the medical profession it defines actual derangement of a joint, which can usually be seen on x-ray. To the chiropractic profession however, the term "subluxation" refers to a process of abnormal movement within a joint, initially too little movement, called a "fixation" and later too much movement as the joint begins to degenerate (Preston, 2003).

Gatterman (1990: 11) defines the subluxation syndrome as an aggregate of signs and symptoms that relates to the pathophysiology or dysfunction of spinal motion segments. Inman (1996) describes it as a motion segment[3], in which there is a functional defect or alteration of the biomechanical and physiological dynamics in a joint, which may cause neuronal disturbances.

This subluxation complex can be diagnosed without the use of invasive techniques, by means of static or motion palpation, by a trained manipulative therapist (Panzer, 1995).

Confirmation of the level of involvement is by means of abnormal end feel of the inter-vertebral joint, abnormal quality of resistance to motion, and tenderness to palpation (Panzer, 1995).

2.4.1 SUBLUXATION PATHOLOGY AND ALTERED BIOMECHANICS

As described by Preston (2003), it is the presence of such subluxations, which frequently affect the spinal nerves resulting in various disorders, depending on the nerve affected. "Adjusting these subluxations aims to retore the neuro-biomechanical harmony of the body" (Preston, 2003:245).

2.5 NEUROMUSCULAR AND PAIN PATHWAYS

Sensory input to the nervous system by mechanoreceptors and nociceptors change sensory stimuli into action potentials, which may in turn initiate a reflex

[3] 2 adjoining vertebral bodies and their connecting soft tissues (Leach, 1994).

protective muscle spasm response, in order to prevent instability and joint degeneration (Fuhr et al, 1997).

Inactive under normal conditions, these receptors become active on irritation due to abnormal mechanics of associated tissues (Fuhr et al, 1997:21-30).

As stated by Fuhr et al (1997:21-30) "joint dysfunction (subluxation), as a result of altered intersegmental and segmental joint motion and postural distortions are thought to create aberrant traffic in neuropathways, perpetrating aberrant reflex alterations, muscle and ligament alterations, inflammatory responses, and resultant pain syndromes.

It is therefore postulated that if the subluxation, can be corrected by means of instrument manipulation, that the above may be avoided or corrected (Inman, 1996).

According to Fuhr et al (1997:42) there is an intimate relationship between nociception and mechanoreception, and that the intensity of nociception is modulated through peripheral and central mechanisms. These in turn can excite and inhibit transmission of afferent nociceptive impulses by means of interneuronal mechanisms. These interneuronal mechanisms are described in detail in the gate control theory of Melzack and Wall (1965).

Fuhr et al (1997) state that any macro or microtrauma may result in a subluxation, which in turn causes nociceptive input, with or without the presence of pain. This in turn sets up reflex muscle spasm. Any movement, stress or abnormal movement due to pain avoidance increases this spasm. A perpetuation of the neuromuscular reflex mechanism occurs as a result, and pain patterns become learned, and sustained (Fuhr, et al 1997).

The gate control system as described by Melzack and Wall (1965) consists of the substantia gelatinosa, a group of small densely packed cells extending the length of the spinal cord. These cells connect with each other via short fibers and Lissauer's tracts. Peripheral nociceptive and mechanoreceptive impulses both travel via this substantia gelatinosa to the central nervous system. Mechanical impulses travelling in the larger mylenated nerve fibers take precedence over impulses from the smaller diameter nociceptive fibers (Fuhr et al, 1997).

As explained by Melzack and Wall (1965) the gate control mechanism is a feedback mechanism of the substantia gelatinosa, which mediates the effect of arriving impulses, and acts as a presynaptic control.

Pain is considered by Melzack and Wall (1965) to be an ongoing process, in which a sensory input results in a protective reflex. As stated by and Wall (1965) "The spinal cord is continually bombarded by incoming nerve impulses even in the absence of obvious stimulation." However, if the a sudden mechanoreceptive impulse is applied, the stimulation via the larger mylenated fibers reaches the substantia gelatinosa before the pain impulse, causing this gate to close and resulting in the presynaptic inhibition of pain (Melzack and Wall, 1965:971-979). Without the stimulus of pain being perceived by the central nervous system, the reflex protective muscle spasm is avoided.

It is based on this theory, that the activator-adjusting instrument was used, to initiate joint movement, which in turn stimulates the mechanoreceptors, resulting inhibition of nociceptive afferants, which decreases the perception of pain (Inman, 1996).

2.6 ALTERED BIOMECHANICS AND THE EFFECTS ON THE SPINE

Dogs' with hip dysplasia will compensate for their loss of hip stability and pain during weight bearing, by shifting balance (Bojrab, 1997:1152). This biomechanical disturbance results in aberrant spinal loading, joint subluxation and muscle spasm. These factors cause a subsequent decrease in rear-end mobility, which once again leads to the unnecessary loading of the affected hip, thus accelerating the disease process, and increasing the likelihood of degenerative joint disease (Bojrab, 1997:1152). As stated by Gatterman (1990) "Mechanical structures fail because they are unable to support the stresses induced by the loads applied to them."

Kirberger (1999) explains that due the difference between maturation rate of the muscles and skeletal structures, as seen with canine hip dysplasia, there is a disparity between biomechanical forces and the supportive soft tissue strength. This is shown by a loss of congruency within the hip joint and results in joint laxity and eventual hip joint degeneration (Kirberger, 1999).

Lambrechts (1999) concurs with this, stating that the laxity of the hip joint is the reason for the development of progressive osteoarthritis. Therefore the aim of treatment is "pain relief and prevention of further joint destruction" (Lambrechts, 1999).

Offierski and Macnab (1983) describe what they call a "secondary hip-spine syndrome" in humans, where spine syndromes are aggravated by deformations of the hip, and the pathology is inter-related. Inflammation within the hip joint may give rise to spinal deformity. They also state that anatomical changes in the spine, such as subluxations, may speed up degeneration in the hip joint, and a flexion deformity of the hip causing anterior pelvic rotation that in turn exaggerates the lumbar lordosis. This lumbar hyperlordosis results in subluxations, which result in symptoms such as pain (Offierski and Macnab 1983).

With canine hip dysplasia, range of motion of the affected hip is decreased due to protective muscle spasm (Bojrab, 1997), with extension being the most affected. It is therefore postulated that by treating any subluxations found within the canine spine, that further degeneration of the dysplastic hip joint can be slowed or halted.

2.7 MANIPULATION
2.7.1 DEFINITION

As described by Rondberg (1996), “A spinal adjustment is a specific application of forces used to facilitate the body’s correction of nerve interference.” It is necessary to produce the correct amount of force and direction, which can be achieved with either the doctor’s hands, or an adjusting instrument to correct or reduce nerve interference, which then allows for improvement of overall body chemistry and healing. (Rondberg, 1996:67).

2.8 THE ADJUSTING INSTRUMENT

In a study by Gemmell and Jacobson (1995), comparing the effects of instrument versus manual manipulation in human subjects with low back pain, it was concluded that there was no advantage of one treatment method over the other, as both groups showed an immediate decrease in pain after the manipulation.

In a similar study on manual versus instrument manipulation for neck pain, Wood et al (2001), both treatment methods had beneficial effects with regards to reducing pain, disability and improving range of motion.

Symons et al (2000) recorded reflex responses associated with instrument adjusting treatment and found that a reflex response was observed, close to the treatment site, in muscles with either origin or insertion at the manipulated vertebral level. Symons et al (2000) postulate in their conclusion that these reflex responses “may reduce muscle hypertonicity, pain and increase the functional capacity of muscles.

The above shows instrument manipulation comparable with manual manipulation, as well as showing favorable responses to either manipulation.

2.8.1 EFFECTS OF THE ADJUSTING INSTRUMENT ON NEUROMUSCULAR PATHWAYS

"The chiropractic profession places emphasis on the role of the nervous system in regulating function in all other systems of the body, and therefore in integrating homeostasis and general health" (Chapman-Smith, 2000:60). It can be postulated that if stimulating the nervous system by means of an adjusting instrument, the afferent input to the central nervous system may be altered and there may be reflex and facilitation changes in the musculoskeletal system.

According to Fuhr et al (1997) manipulation initiates joint movement that stimulates mechanoreceptors, which in turn inhibits nociceptive afferents and decreases pain perception.

2.9GLUCOSAMINE SULPHATE

2.9.1 INTRODUCTION

Glucosamine sulphate was chosen as a control for this study due to its comparable efficacy to non-steroidal anti-inflammatory drugs, NSAIDS, without the same risks of side effects (Reginster, 2001).

Despite their widespread use and perceived safety, NSAIDS have significant risk of severe complications. The more serious associated adverse effects include gastrointestinal ulceration and hemorrhage (Dabbs and Lauretti, 1995). Other reported side effects are dyspepsia, nausea seen as a lack of appetite, with or without increased salivation, and gastritis (Reginster et al, 2001).

More recently nutritional supplementation with glucosamine sulphate has been shown as a safe, effective and natural alternative to NSAIDS for the symptoms of inflammatory joint conditions (Gottlieb, 1997). In a conference at the National Institutes of Health, Hochberg et al (2000) stated that glucosamine has been used for many years in veterinary medicine to treat the symptoms of arthritic conditions. Hochberg et al (2000) also state that glucosamine is a naturally occurring compound within the body and may be involved in the repair and maintenance of normal cartilage.

In a study by Reginster et al (2001) the long-term effects of glucosamine sulphate were addressed and significant improvements in both pain and physical function were noted when compared with placebo. There were also no substantial differences, in terms of side effects noted between glucosamine and placebo over the three years, with most of the adverse effects, including: abdominal pain, dyspepsia, diarrhoea, and increased blood pressure, being transient and mild to moderate in nature (Reginster et al, 2001).

Reginster et al (2001) states that the long-term administration of glucosamine sulphate over years can prevent joint structure changes in those patients suffering with osteoarthritis. Noack et al (1994) concluded that glucosamine sulphate might be a safe and effective symptomatic, slow acting drug for osteoarthritis. In a placebo-controlled double blind investigation into the therapeutic activity of glucosamine sulphate by Drovanti (1980), the time taken for the glucosamine supplement to show a reduction in symptoms was twenty days.

The above mentioned imply that glucosamine sulphate is not a fast acting compound, and it is due to the above reasons that glucosamine sulphate was chosen as the control for this study.

In a randomized, controlled trial of glucosamine for treating osteoarthritis of the knee, in ninety-eight human subjects, Rindone et al (2000) concluded that glucosamine was no better than a placebo at reducing pain. They also stated that two of the ninety-eight participants taking glucosamine, and four taking placebo withdrew from the study due to adverse side-effects. From this it was determined that there are no significant side effects from either glucosamine or placebo, so the use of glucosamine as a control in this study was not of high risk.

Ruane and Griffiths (2002) compared the use of glucosamine sulphate to ibuprofen for joint pain, and results showed the two to be of similar efficacy. It was therefore concluded that glucosamine sulphate is as effective at relieving joint pain as ibuprofen, but with fewer side-effects.

2.9.2 PHARMACOLOGICAL ACTIONS

Postulated pharmacological actions include direct action of glucosamine sulphate on cartilage. It is hypothesized that glucosamine sulphate rebuilds damaged cartilage (Drovanti, 1980).

According to the long-term study by Reginster et al (2001) the precise mechanism of action has not yet fully been explained, but is likely due to the stimulation of anabolic activity, such as the synthesis of proteoglycans, which occurs within cartilage metabolism.

CHAPTER THREE

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1 INTRODUCTION

This chapter provides details of the study design, data collection, the subjects and the interventions utilized. An overview of the questionnaire, the process of data evaluation and statistical analysis are also included.

3.2 DESIGN

This study, is a pilot, prospective, randomized controlled clinical trial.

3.3 THE DATA

The data consisted of both primary objective and subjective data, and secondary data.

3.3.1 The Primary Objective Data

Objective data and treatment form (Appendix E). Including; motion palpation findings (Schafer and Faye, 1990), orthopaedic tests, goniometer readings to assess range of motion, hind-leg girth measurements and hind-foot tarsal diameter, to assess muscle wasting and weight bearing.

Objective data was collected from both groups' at all five consultations, including the initial. This data was then correlated, analyzed and compared both within and between each group.

3.3.2 The Primary Subjective Data

Consisted of details of the canine, including the owner's perception of their canine's functional ability (Appendix C).
The owner's perception of their canine's disability through a veterinary approved Canine Hip Dysplasia disability index form, which determined the amount of physical disability due to pain (Appendix D).

3.3.3 The Secondary Data

Relevant literature was obtained from various sources, including journal articles, books, pharmaceutical research, Medline, Mantis, the Internet and it's relevant search engines.

3.4 THE SUBJECTS

3.4.1 Advertising

This study was limited to canines previously diagnosed with hip dysplasia from the greater Ethekwini municipal area. The owner's of these canines were referred to the researcher by advertisements placed at the Durban Institute of Technology Chiropractic Clinic and the Westville Veterinary Hospital, as well as at various Dog Shows and Kennel Club newsletters (Appendix F).

3.4.2 Sampling: recruitment

The population of 30 canines was chosen using purposive sample techniques:

- ❖ Inclusion of canines into the study was determined by qualified veterinary surgeons based on suitability, by means of a radiographic diagnosis.

- incidence of hip dysplasia in the canine population was dependent on the number of dogs within a geographical location.

3.4.3 Telephonic Interview

Interested owner's of canines whom had seen the advertisements, or who had heard of the study by word of mouth, telephoned the researcher for more details regarding this study. Any initial queries regarding the study were addressed during the telephonic interview, and if interested, they were booked in for an initial consultation.

Only canines previously diagnosed with hip dysplasia by a qualified veterinary surgeon were considered for this study.

3.4.4 Sampling: group allocation

Thirty canines were consecutively selected from those who responded. No bias was given to breed, gender or levels of disability, provided the canine was determined a suitable candidate for this study by a qualified veterinarian.
The canines were randomly assigned into one of two groups (15 in each of the two treatment protocols).

3.5 INCLUSION AND EXCLUSION CRITERIA

3.5.1 Inclusion Criteria

Each owner was interviewed to assess the suitability of their canine for the study with regards the following:

- Only canines diagnosed with hip dysplasia, and showing symptoms were accepted.
- Suitability for this study was determined by means of radiographic arthritic changes within the hip joints.
- Any grade of dysplasia was accepted on the basis of symptomatology.
- Hip dysplasia had to be the cause of the above symptoms, and other conditions affecting the elbows and knees were ruled out. Canines with any other pathologies were excluded
- Those canines that were receiving current treatment for hip dysplasia were excluded, unless current medication could be stopped for the duration of this study without any detriment to the canine.
- Owners had to be prepared to commit to four treatments over a two-week period with a two-week follow-up.
- The owner had to sign the informed consent and compliance forms.

3.5.2 Exclusion Criteria

- Any canine with a systemic or unrelated local pathology was not included.
  If any contra-indications to articular manipulation were suspected on examination the canine was not included.
- Canines not previously diagnosed with hip dysplasia by means of a radiograph were not permitted to partake in this study.
- Canines were not permitted to receive any other form of treatment whilst in this study. If the canine became ill, it was withdrawn from this study, to prevent alterations in pain threshold due to illness or medication.
- Any history of hip replacement surgery warranted exclusion from this study.
- Extremely anxious or aggressive canines were excluded from this study.

3.6 ETHICS

Ethics was as per the University of Kwa-Zulu Natal and the Durban Institute of Technology. Ethical clearance required each owner to complete and sign informed consent and compliance form (Appendix B). Each owner was told the precise nature of the study, including the possible side effects of manipulation and the glucosamine used. They were also informed that the group to which they were allocated would be randomly determined. The owners were free to withdraw their canines from the study at anytime and for whatever reason. All information was treated as confidential.

3.7 CLINICAL PROCEDURE

3.7.1 Assessments and Data Capturing

Those owner's whose canines were eligible for the study were required, at the initial consultation, to read and sign the consent and compliance form (Appendix B), and complete the veterinarian approved canine hip dysplasia disability index form (Appendix D).

The owners, at all consultations, completed the disability index form (Appendix D). The researcher at the initial consultation completed a new-patient form (Appendix C), and at all consultations, including the first filled in the objective data and treatment form.

The above information and measurements were obtained at the beginning of each consultation, for canines in both groups.

3.7.2 Time and Visit Frequency

Both groups were involved in this study for a four-week period. Canines in both groups were required to come in for two consultations a week within a two-week time frame (Kamen 1996: 137). They were then required to come in for a follow-up consultation two weeks later.

Owners of canines in both groups received glucosamine sulphate for their canines, for the duration of the study (one- month).

Group two received glucosamine sulphate as did group one, as well as four treatments (including a treatment at the initial consultation) consisting of instrument manipulation, within a two-week time frame, as indicated by Kamen (1996: 137).

Canines in both groups were then required to come in for a follow-up consultation two weeks later.

Owners were not purposefully made aware of which treatment group each canine was in, this was done to help blind the study and increase the validity of the results. However, the owners of canines in both groups were present when the treatment was administered.

3.8 INTERVENTIONS

3.8.1 Glucosamine Sulphate

The same glucosamine sulphate supplement was administered to all canines in capsule form, each capsule containing the following: gelatinous shell 100mg, glucosamine sulphate 500mg, vitamin C 90mg, and Ca (from Ca ascorbate) 10mg.

The owners of the canines were required to give them the glucosamine supplement on a daily basis.

The owners of the canines were blinded as to which manufactured brand of glucosamine sulphate supplement their canines were receiving, to remove any bias on the owner's part. This was achieved by providing the owners with their supply of capsules in a standardized veterinary medication bag; the same as those used by the Westville Veterinary Hospital. The bags had the dosage, in terms of number of capsules, and number of times a day the capsules were to be taken clearly marked on each bag, with respect to each individual canine's needs. The dosage was standardized to 500mg of glucosamine sulphate per 10 kilograms body weight, daily.

The owners were advised to give the supplement once daily, without food if possible. If any mild adverse effects occurred, they were advised to split the dosage and to administer with food. "About 4-5% of pets develop minor diarrhea. This can be alleviated by reducing the dose, giving with a meal, and splitting the dose between morning and evening" (Rogers, accessed 8 September 2002).

The glucosamine was provided as part of the research, which ensured that all the canines received the same supplement.

3.8.2 The Adjusting Device

The device consists of a spring-loaded rubber tip, which when released, fires at a rate of 2- 4 milliseconds per activation. This is of importance, as it is quick enough to deliver a force, (using the principles of Newton's law of force = mass x acceleration), which is sufficient to reduce a subluxation (Inman, 1996).

This tool is also of benefit, in that it allows the practitioner to deliver sufficient force, using a small mass, being able to direct that force, and being able to deliver it before the dog can offer any resistance.

3.8.3 Manipulative Therapy

For all the manipulations delivered, an adjusting device was used. This instrument was chosen as it helped standardize results by controlling the speed, force and direction of thrust.

The involved joints were adjusted using this device as described by Inman (1996). The direction of thrust was according to motion palpation findings, where a specific manipulation is used to restore the desired movement (Gatterman, 1990: 50-51).

The anatomy of the canine spine:
The canine spine consists of 50 or more vertebrae, with a distribution of 7 cervical, 13 thoracic, 7 lumbar, 3 sacral and varying numbers of coccygeal vertebrae ranging from 20 to 23, depending on the breed of canine (Sisson and Grossman, 1953). The vertebrae were palpated for the quality of end feel and then manipulated if necessary. Coccygeal vertebrae were not manipulated, in order to standardize results, as these varied in number between breeds.

In the lumbar spine, the contact point is the spinous process with the thrust being delivered from dorsal to ventral. (Inman, 1996).
Contact points in the pelvis allow motion of the hemipelvis around the sacroiliac joint.

These points are as follows:

- the dorsal aspect of the iliac wing,
- the rostral (anterior) aspect of the iliac wing,

- the ventral aspect of the iliac wing and
- the ischial tubercle.

3.9 INTERVENTION ALLOCATIONS

Canines in both groups received glucosamine sulphate supplementation as a control for this study, as follows: 500mg per 10 kilograms body-weight was administered to the canine daily, for the duration of this study (Consumer's Guide to Glucosamine for Pets, accessed 8 September 2002).

Canines in group one received no instrument manipulation at any consultation.

Group two canines received glucosamine sulphate supplementation and four treatments (including the initial) within a two-week period, and were then required to come in for an evaluation two weeks later.

The treatment for the canines on group two consisted of instrument manipulation via an adjusting device (Appendix K), according to their motion palpation findings.

3.10 MEASUREMENTS

3.10.1 Objective Measurements

The objective data was obtained by means of orthopaedic tests, motion palpation findings, goniometer readings and hind-limb girth and tarsal diameter measurements. Readings were taken at all consultations and recorded on the form provided (Appendix E).

3.10.1.1 Orthopedic Tests

Orthopedic tests are defined as assessments relating to the locomotor system, and involve examination of the mechanical structure of the body.

The following tests adapted from Kamen (1996) were used as part of this study:

3.10.1.1.1 Lumbar facet challenge

This consists of placing a thumb on the tip of the spinous process of the lumbar vertebrae, and pushing with varying amounts of force. This test is performed with the canine in a standing position. Positive findings were pain responses.

3.10.1.1.2 Lumbar extension test

Test is performed by approaching the standing dog from behind, and grasping both thighs, to then lift the dog's rump off the ground, inducing lumbar extension. The dog will only allow this if he/she is pain free. A positive test is therefore considered to be any pain or objections when performing this test.

3.10.1.1.3 Hip abduction test

The dog is positioned in a side lying position. The pelvis is then stabilized and the hip on the free side is abducted. A positive test results in a popping sound or signs of pain.

3.10.1.1.4 Hip instability test

With the dog standing on all four feet, one hind leg is raised at a time. The opposite hind leg is then inspected for any signs of weakness or muscle fatigue, such as shaking or fasciculation's of the muscles in the weight-bearing limb.

3.10.1.1.5 Hind limb weight-bearing test

With the dog standing on all fours, the examiner's hand is placed under each hind paw, one at a time. A positive test is indicated by a decrease in weight bearing on the painful side.

This can be confirmed by lifting the hind limbs from the ground, one at a time. The leg with less weight being transferred through it will come up off the ground more easily. The length of the claws is another indication as to how much weight is being transferred through the limb.

3.10.1.1.6 Wheelbarrow test

With the dog standing on its hind legs, with its front legs being supported by the examiner, it is encouraged to walk forward a few steps if possible.

A positive test is indicated by the dog's inability to stand on its hind limbs, or its inability to support its weight in this position.

The above tests will each be given a score of 1 for a positive result, and a score of 0 for a negative finding. These results will be added and given a total score out of 6. These scores will then be analysed and interpreted using the appropriate statistical tests.

3.10.1.2 Motion Palpation

Motion palpation is the palpatory diagnosis of passive and active segmental joint range of motion (Gatterman, 1990).

It is performed by springing each vertebra in each of its planes of motions or by monitoring the relative motion between bony landmarks. Clinically motion palpation assesses vertebral function using refined palpatory skills. Normal motion is defined by the spine yielding to the push, and rebounding smoothly. Fixation of a segment is perceived as a failure of the spine to yield to the springy motion, and is instead perceived as an abrupt stop in motion (Gatterman, 1990).

Mechanical analysis of joint function has shown that some elasticity is present in the normal ligamentous structure of each joint. This is referred to as “joint play” (Gatterman, 1990).

It is the loss of joint play at the subluxated[1]segment, which responds to the force of the manipulation (Gatterman, 1990).

According to Kamen (1996) there are several predictable palpable features of vertebral subluxation: tight and tender spinal musculature, with increased heat over the tight muscles and restricted vertebral joint movement.

3.10.1.3 Goniometer Readings

We have used a goniometer to measure hip range of motion in this study.

The goniometer is an instrument used for measuring degrees of freedom of a joint within its range of motion, that is, the range of translation and rotation of a joint for each of its six degrees of freedom (Gatterman, 1990).

Range of motion is an important means of evaluating and monitoring joint function.

[1] subluxation –“ Aberrant relationship between two adjacent articular structures, which may have functional or pathological sequelae, causing an alteration in the biomechanical and/or neurophysiological reflexes of these articular structures, their proximal structures, and/or body systems that may be directly or indirectly affected by them” (Gatterman, 1990). Willams and Wilkins, Baltimore, USA.

The measurement procedure does not alter the progression of the patient's condition.

It has been shown to demonstrate good intra-examiner and inter-examiner reliability in human studies.

As cited by Gottlieb (1997) "Spinal manipulation increases intersegmental joint range of motion and relaxes hypertonic muscles via a fast stretch reflex."

Manipulation improves biomechanical and neurological function by restoring normal motion to the spine (Gottlieb, 1997).

In a study by Whittingham and Nilsson (2001) on the cervical spine, results showed that range of motion increased significantly after manipulation.

Gatterman (1990: 170) defines segmental hypermobility as a reversible physiological joint dysfunction. Compensatory hypermobility is a common finding with sublxations of the spine. If the lumbar spine or sacroiliac joints are subluxated, the hip joints may become hypermobile in compensation. A hypermobile hip joint may result in associated muscle spasm, which in turn leads to an overall decrease in hip range of motion.

According to Gatterman (1990: 171) manipulation of adjacent hypomobile segments or joints, would theoretically decrease the range of motion in the hypermobile segments.

It is possible that range of motion may appear normal both prior to and after the riddance of the manipulative lesion (Gatterman, 1990).

3.10.1.4 Hind-leg girth measurements

The purpose of measuring hind limb thigh and calf diameters was to establish any evidence of muscle atrophy, due to hip dysplasia. Decreased use of the dysplastic hip usually results in disuse atrophy of the associated muscles.

3.10.1.5 Hind-foot tarsal diameter

Measuring the diameter of the hind-foot tarsals would help to establish if there was a discrepancy in the weight bearing capacity of each hind leg, due to pain or muscle wasting from long-term hip dysplasia.

3.10.2 Subjective Measurements

Subjective measurements were taken from questionnaires which owner's of the canines had to complete at all consultations. The questionnaire used was the the veterinarian approved canine hip dysplasia disability index form (Appendix D).

3.10.2.1 Background information on the veterinary approved Canine Hip Dysplasia disability index form

This scale was piloted to improve the evaluation and assessment of canine hip dysplasia, by asking canine owners' pertinent questions relating to their canine's disease state and related disability. The researcher developed the scale, as no satisfactory questionnaires are currently available, that could be clinically utilized as subjective tools in the assessment of canine hip dysplasia.

In this questionnaire, the owner's perception of their canine's pain and disability was rated. The owner could choose one of four options regarding their canines' pain intensity, disability and appetite, and the points were assigned accordingly. The minimum number of points a canine could score is 10 and the maximum number of points is 40.

3.10.2.2 Piloting procedure

Modification of a commonly used Neck Disability Index Questionnaire was utilized to develop a canine hip dysplasia disability index form. The questionnaire was given to a focus group, consisting of veterinarians, veterinary nurses, chiropractors and dog owners (Appendix G). Their recommendations were noted and included followed in order to develop the questionnaire.

3.10.2.3 Face validity

This canine hip dysplasia disability index form was then shown to veterinary surgeons involved with the management and treatment of canine hip dysplasia, who then evaluated the scale and approved the questionnaire in its current form (see Appendix D). The subjective scale was developed via focus groups in order to improve the diagnostic ability of hip dysplasia, however, its reliability and validity has not been established beyond the level of face validity.

3.11 SPECIFIC TREATMENTS OF THE SUBPROBLEMS

3.11.1 The First Sub-problem

The first sub-problem was to evaluate the relative effectiveness of instrument manipulation in the management of symptomatic canine hip dysplasia, in terms of subjective clinical findings, using glucosamine sulphate as a control.

3.11.2 The Second Sub-problem

The second sub-problem was to evaluate the relative effectiveness of instrument manipulation in the management of symptomatic canine hip dysplasia, in terms of objective clinical findings, using glucosamine sulphate as a control.

3.11.3 The Third Sub-problem

The third sub-problem was to integrate, analyze and interpret the subjective and objective data collected in this study, in order to determine if instrument manipulation is effective in alleviating the short-term signs and symptoms associated with canines hip dysplasia.

3.12 STATISTICAL ANALYSIS

3.12.1 TREATMENT OF THE DATA

3.12.1.1 Objective Data

The objective data were treated as follows:

- Motion palpation findings were calculated by means of Spearman’s correlation between age, weight and number of subluxations at baseline. A comparison of median subluxations by breed was done using Kruskal –Wallis method.

- Fisher’s exact tests for baseline differences between control and treated groups were used for orthopedic tests. Changes in orthopedic test results over the 5 visits between both groups were analyzed using (GEE), generalized estimating equations. The total orthopedic score was analyzed using Repeated measures ANOVA.

The results based tests which included degrees and length based measurement scales, were analyzed using Repeated measures ANOVA, as these were normally distributed quantitative variables.

3.12.1.2 Subjective Data

The subjective data were treated as follows:

- The questionnaire that the owner's of the canines had to complete was screened to ensure that it had been filled in correctly.

- The diagnostic based functional ability questions (Appendix C) were awarded a Yes/ No answer, which was later awarded a numerical value and analysed statistically, using frequencies and percentiles.

- The subjective questionnaire (Appendix D) was awarded a numerical rating as follows: each question had a range of 4 alternative answers, increasing in severity of symptoms, which were awarded a numerical score from 1 to 4. These were then totaled and awarded a score ranging between a minimum of 10 and a maximum of 40. These totals were analyzed using the Repeated measures ANOVA for total disability index score, and mean and median values for question by treatment group over time, were also plotted.

3.12.2 STATISTICAL ANALYSIS OF THE DATA

Data were captured in MS Excel and imported into SPSS version 12.0 (Chicago, Ill) and STATA version 8 (STATA corp. Texas, USA) for analysis.

Quantitative variables were checked for normality and if normally distributed, parametric statistical methods were used to describe and compare groups. Non parametric Mann-Whitney tests were used to compare independent groups with skewed data. Repeated measures ANOVA was used to analyse normally distributed quantitative variables for the main effects of time and group, as well as a time by group interaction.

Categorical variables (independent groups) were analysed bivariately using Pearson's chi square and over time (5 visits- paired groups) using generalized estimating equations in STATA for the effect of the intervention.

Hypothesis testing rule: a two-sided p value of <0.05 was considered as statistically significant.

CHAPTER FOUR

RESULTS

4.THE RESULTS

4.1 INTRODUCTION

This chapter covers the results obtained from the statistical analysis of the objective and subjective data, for both the control and the experimental groups.

Control group – Glucosamine Sulphate (**Group 1**)
Experimental group – Glucosamine Sulphate and instrument manipulation (**Group 2**)

4.2 STATISTICAL METHODS

Data were captured in MS Excel and imported into SPSS version 12.0 (Chicago, Ill) and STATA version 8 (STATA corp. Texas, USA) for analysis.

Quantitative variables were checked for normality and if normally distributed, parametric statistical methods were used to describe and compare groups. Non parametric Mann-Whitney tests were used to compare independent groups with skewed data. Repeated measures ANOVA was used to analyse normally distributed quantitative variables for the main effects of time and group, as well as a time by group interaction.

Categorical variables (independent groups) were analysed bivariately using Pearson's chi square and over time (5 visits- paired groups) using generalized estimating equations in STATA for the effect of the intervention.

Hypothesis testing rule: a two-sided p value of <0.05 was considered as statistically significant.

4.3 ABBREVIATIONS

SD standard deviation

IQR interquartile range

OR odds ratio

CI confidence interval

4.4 RESULTS

Although the sampling used in this study could not ensure a totally representative sample of dogs with hip dysplasia, the most commonly affected breed in this study was the Labrador (n=7, 23.3%). This was followed by the German Shepherd (n=6, 20%). The distribution of breeds in this study is shown in **Table 1**. If the German Shepherd cross breeds were combined with the German Shepherd, this would show the German Shepherd type breeds to be the most commonly affected (n=9, 30%).

Table 1: Distribution of breeds of dogs in the study

Breed	Frequency	Percent
Labrador	7	23.3
German Shepherd	6	20.0
Africanus	2	6.7
Boerboel	2	6.7
Bulldog	2	6.7
Golden Retriever	2	6.7
GSD X	2	6.7
Rottweiler	2	6.7
Bullmastiff	1	3.3
Great Pyrenees	1	3.3
Rhodesian Ridgeback	1	3.3
St. Bernard	1	3.3
White Shepherd	1	3.3
Total	30	100.0

The most common age of dog in the study (mode) was 5 years. The mean age was 4.4 years (SD 2.46), and the median was 5 years (IQR 2.2.5 to 6 years). These statistics of the group of participants as a whole (n=30) is shown in **Table 2**.

Table 2: Statistics for age of dogs in the study

N	Valid	30
	Missing	0
Mean		4.40
Mode		5
Std. Deviation		2.458
Minimum		1
Maximum		12
Percentiles	25	2.25
	50	5.00
	75	6.00

The most common weight (mode) of dog was 30 Kg. The mean was 37 Kg (SD 12.49) and the median was 34.5Kg (IQR 29.65 to 39Kg).

Table 3: Statistics for weight of dogs in study

N	Valid	30
	Missing	0
Mean		37.00
Mode		30
Std. Deviation		12.494
Minimum		22
Maximum		79
Percentiles	25	29.65
	50	34.50
	75	39.00

50% of the dogs favoured one leg over another (n=15). This is shown in **Table 4**.

Table 4: Number and percent of dogs which favoured one leg over another at baseline

FAVOUR ONE LEG OVER OTHER?	Frequency	Percent
N	15	50.0
Y	15	50.0
Total	30	100.0

83.3% of dogs showed a change in gait at baseline (n=25). This is shown in **Table 5**.

Table 5: Number and percent of dogs which showed a change in gait at baseline

CHANGE IN GAIT?	Frequency	Percent
N	5	16.7
Y	25	83.3
Total	30	100.0

There was no significant difference in weight of dogs which showed a change in gait and those which did not show a change in gait (p = 0.169). This is shown in **Table 6**. The group, which showed a change in gait, had a non-significantly lower median weight than the group, which did not show a change in gait.

Table 6: Mann-Whitney test for difference in weight between two groups

CHANGE IN GAIT?	Median weight (kg)	Mean Rank	Sum of Ranks	p
no	38	20.50	102.50	0.169
yes	34	14.50	362.50	
Total	34.5			

Because of the many categories of breed of dog, with low numbers in each category, no reliable statistical estimates of comparison for change in gait by breed could be achieved. It is worthwhile to note that in most breeds 100% of the dogs were affected by a change in gait, while in others none of the dogs showed a change in gait (Great Pyrenees and White Shepherd). This may however, have been influenced by chance due to the low numbers of dogs in most breed categories. The distribution is shown in **Figure 1**.

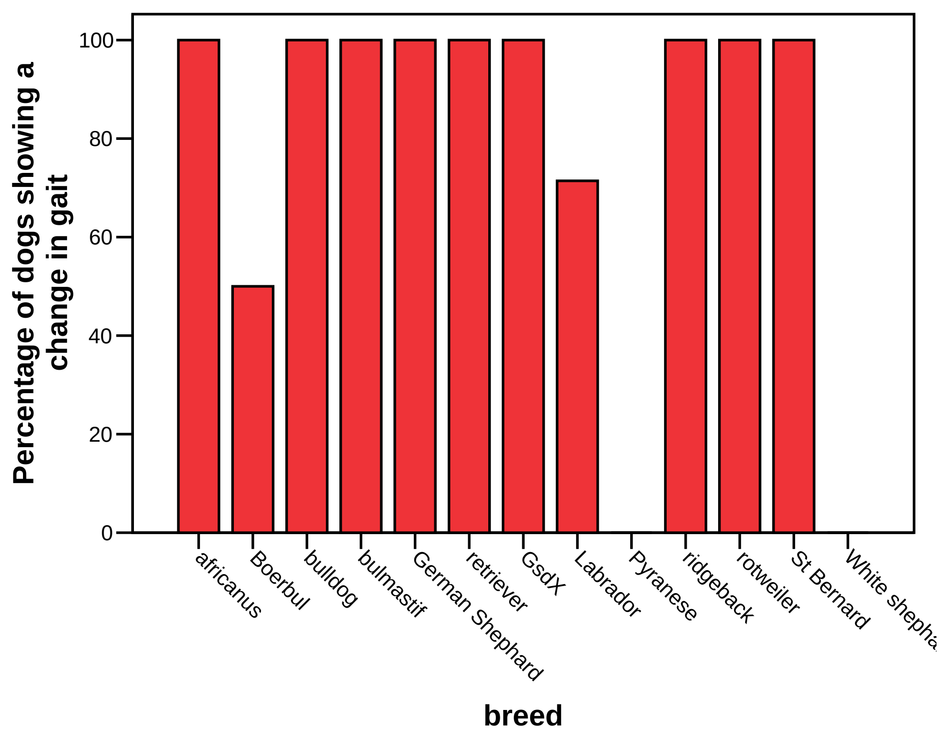


Figure 1: Percentage of dogs per breed which showed a change in gait

63.3% of the dogs could squat (n=19) at baseline. This is shown in **Table 7**.

Table 7: Number and percentage of dogs who could and could not squat at baseline.

CAN DOG SQUAT?	Frequency	Percent
N	11	36.7
Y	19	63.3
Total	30	100.0

Neither weight nor age significantly affected their ability to squat. This is shown in **Table 8**. The difference in weight was of borderline significance (p = 0.064). Those who could squat were marginally heavier.

Table 8: Mann-Whitney test for difference in weight and age between two groups

	CAN DOG SQUAT?	Median	Mean Rank	Sum of Ranks	p
WEIGHT IN KG'S	no	30	11.59	127.50	0.064
	yes	36	17.76	337.50	
	Total	34.5			
AGE IN YEARS	no	3.5	13.09	144.00	0.268
	yes	5	16.89	321.00	
	Total	5			

The percentage of dogs, which could squat by breed, is shown in **Figure 2**. Again it was not possible to get a statistical estimate of the significance of the association, as there were too many categories of breed of dog with low numbers. The trends are shown below.

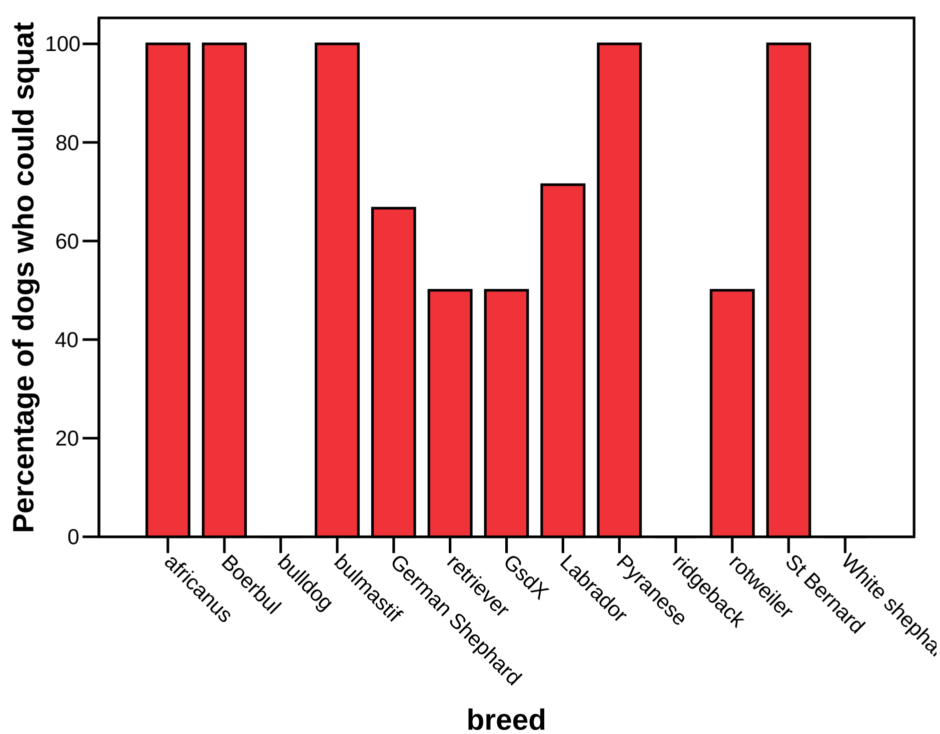


Figure 2: Percentage of dogs who could squat at baseline by breed

Number of subluxations at baseline ranged from 2 to 8, with a median of 4. There was no correlation between number of subluxations at baseline and age and weight of the dogs (p = 0.316 and 0.258). Spearman correlations are shown in **Table 9**.

Table 9: Spearman's correlation between age, weight and number of subluxations at baseline

		AGE IN YEARS	WEIGHT IN KG'S
subluxations at baseline	Spearman's Correlation Coefficient	.190	.213
	p (2-tailed)	.316	.258
	N	30	30

Median number of subluxations at baseline by breed is shown in **Table 10**. There was no significant difference between the breeds (p = 0.143), but they ranged from 6 in Rottweilers to 2 in Rhodesian Ridgebacks.

Table 10: Kruskal-Wallis comparison of median subluxations by breed

Breed	N	Mean Rank	Median	p
Africanus	2	6.00	2.50	0.143
Boerboel	2	9.50	3.00	
Bulldog	2	16.25	4.00	
Bullmastiff	1	23.00	5.00	
German Shepherd	6	22.75	5.00	
Golden Retriever	2	9.50	3.00	
GSD X	2	19.75	5.50	
Labrador	7	14.36	4.00	
Great Pyrenees	1	9.50	3.00	
Rhodesian Ridgeback	1	2.50	2.00	
Rottweiler	2	26.00	6.00	
St. Bernard	1	9.50	3.00	
White Shepherd	1	9.50	3.00	
Total	30		4.00	

The median (IQR) number of subluxations at each level at each time point is shown in **Table 11**.

Table 11: Median (IQR) number of subluxations at each level at each visit in all participants (n=30)

Visit	Cervical	Thoracic	Lumbar	Sacro-illiac
1	1 (1-1)	1 (1-3)	0 (0-1)	1 (0-1)
2	1 (1-1)	1 (0-2)	0 (0-1)	1 (0.75 -1)
3	1 (0.75 -1)	1 (0-2)	0 (0-1)	0 (0-1)
4	1 (1-1)	1 (0.75-3)	0 (0-1)	0 (0-1)
5	1 (1-1)	1.5 (0-3)	0 (0-1)	1 (1-1)

The median (IQR), minimum and maximum number of subluxations at each spinal region at each time point is shown for the control group in **Table 12**.

Table 12: Median (IQR), minimum and maximum number of subluxations at each visit in the control group.

Visit	Cervical	Thoracic	Lumbar	Sacro-iliac
1	1 (0-1)	1 (0-3)	0 (0-2)	1 (0-1)
2	1 (0-1)	2 (0-3)	0 (0-2)	1 (0-1)
3	1 (0-1)	2 (0-3)	0 (0-3)	1 (0-1)
4	1 (0-1)	2 (1-4)	0 (0-2)	1 (0-1)
5	1 (0-1)	2 (0-3)	0 (0-3)	1 (0-1)

The median (IQR), minimum and maximum number of subluxations at each spinal region at each time point is shown for the treatment group in **Table 13**.

Table 13: Median (IQR), minimum and maximum number of subluxations at each visit in the treatment group.

Visit	Cervical	Thoracic	Lumbar	Sacro-iliac
1	1 (1-1)	1 (0-4)	0 (0-2)	1 (0-1)
2	1 (0-1)	1 (0-2)	0 (0-2)	1 (0-1)
3	1 (0-1)	0 (0-2)	0 (0-2)	1 (0-1)
4	1 (0-1)	1 (0-3)	0 (0-1)	1 (0-1)
5	1 (0-1)	1 (0-4)	0 (0-1)	1 (0-1)

The median (IQR), minimum and maximum number of total subluxations at each time point is shown for both groups in **Table 14**.

<u>Table 14: Median (IQR), minimum and maximum number of total subluxations by time by group.</u>

Visit	Control	Treated
1	3 (2-8)	4 (2-7)
2	4 (2-8)	3 (2-5)
3	4 (2-8)	2 (1-5)
4	5 (2-8)	3 (1-5)
5	4 (1-8)	3 (1-7)

Baseline differences in orthopedic tests were assessed by Fisher exact tests. There were no significant differences between control and treated dogs at baseline with regard to the results of these tests. This is shown in **Table 15**.

<u>Table 15: Fisher's exact tests for baseline differences between control and treated group for orthopedic tests</u>

Test	Fisher's exact p value
Lumbar facet	0.139
Lumbar extension	0.215
Hip abduction	0.215
Hip instability	1.000
Hind leg weight bearing	1.000
Wheel barrow	0.710

Changes in orthopedic test results over the 5 visits and between the control and treated groups was assessed in STATA using generalized estimating equations (GEE). The results are shown in **Table 16**. The odds of the condition being present rather than absent at each of the visits, was compared between the groups. The odds ratio, gives the effect of treatment relative to control for the presence of each condition. Thus an odds ratio under 1 means that the treatment group were less at risk of the condition over time than the control group and vice versa. The odds ratio for lumbar facet test was 2.35. meaning, that treated dogs were 2.35 times more at risk than control dogs to show a positive test. However, the p value was not significant (p = 0.170). The odds ratio for lumbar extension was 0.071, meaning that treated dogs were 92.9% less at risk than control dogs to show a positive test. The p value for this odds ratio was significant and the 95% confidence intervals did not overlap with 1. Similarly with the wheel-barrow test, treated dogs were 66.7 % less likely to show a positive test than control dogs. This, was marginally statistically significant, however, the hip instability was not. The estimates, for the hip abduction test and hind leg weight-bearing test, could not be computed by the program. Thus for the lumbar extension test and possibly the wheel-barrow test, the treatment had a significant protective effect.

Table 16: Results of GEE modeling for treatment effect in orthopedic tests

Test	Odds ratio for treated vs. control	95% CI for OR	P
Lumbar facet	2.35	0.69 – 7.95	0.170
Lumbar extension	0.071	0.013 – 0.383	0.002*
Hip abduction	#		
Hip instability	0.456	0.158 – 1.311	0.145
Hind leg weight bearing	#		
Wheel barrow	0.333	0.108 – 1.028	0.056

non-estimable
* statistically significant at the 0.05 level.

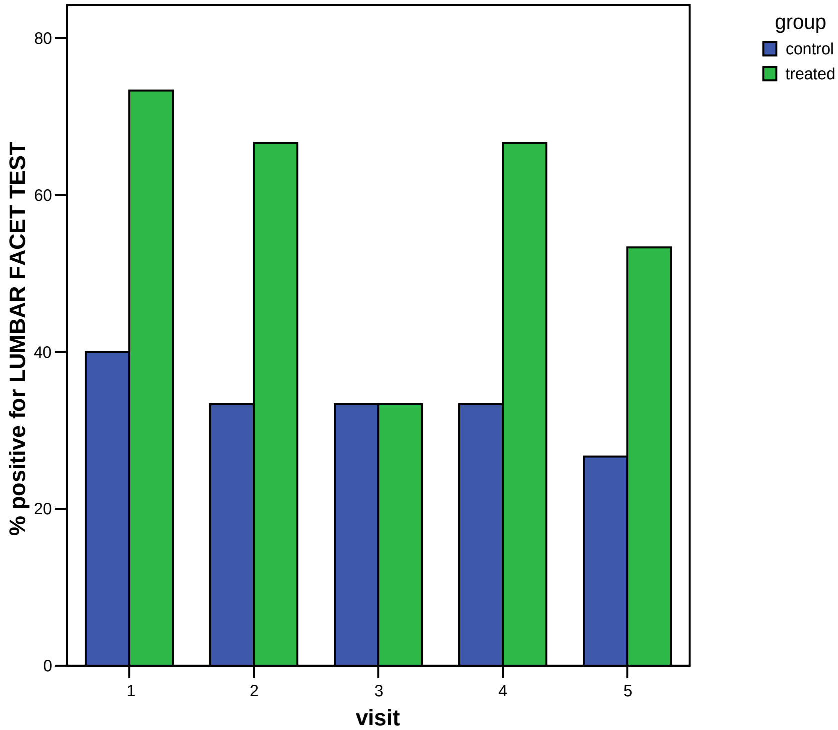


Figure 3:Lumbar facet test by visit by treatment group

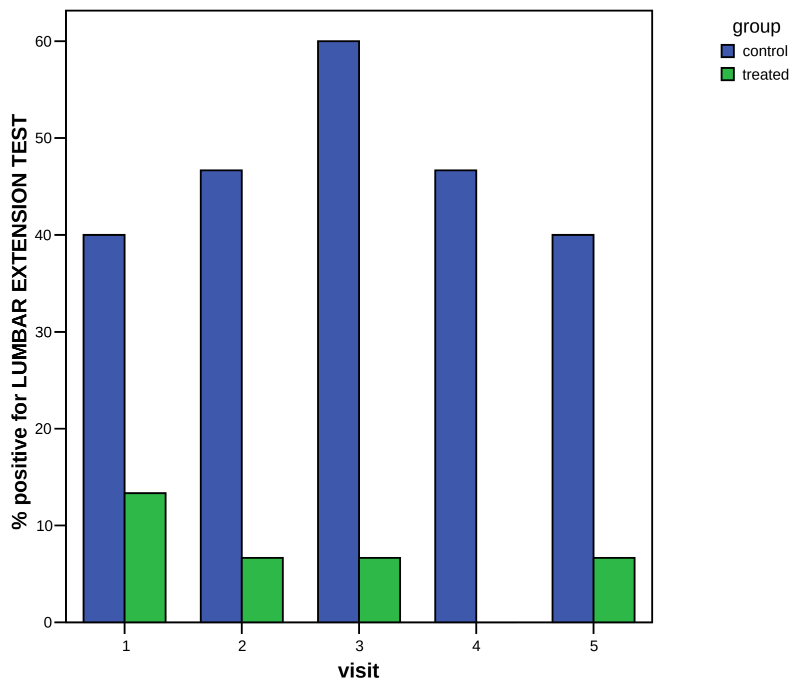


Figure 4: Lumbar extension test by visit by treatment group

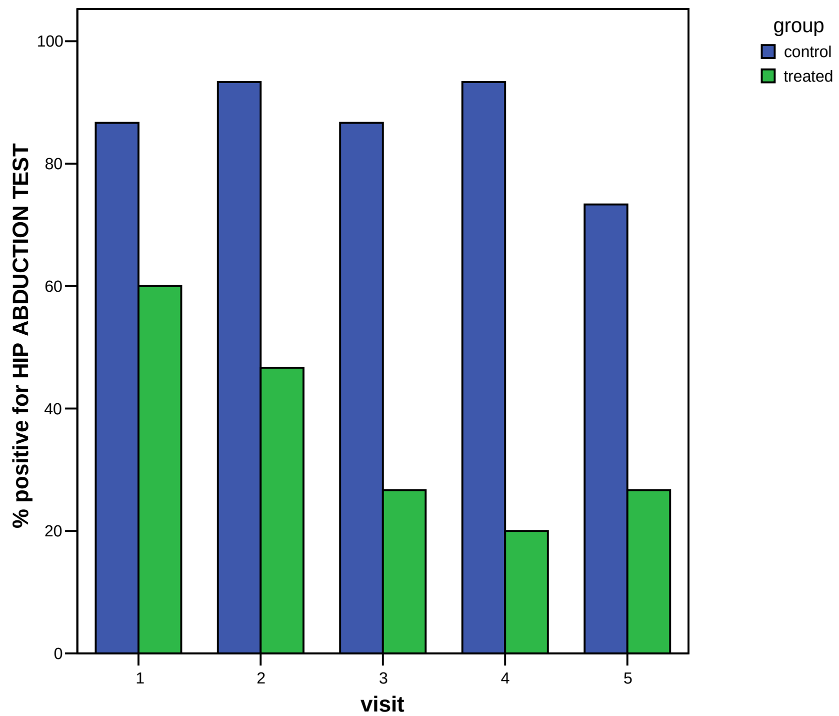


Figure 5: Hip abduction test by visit by treatment group

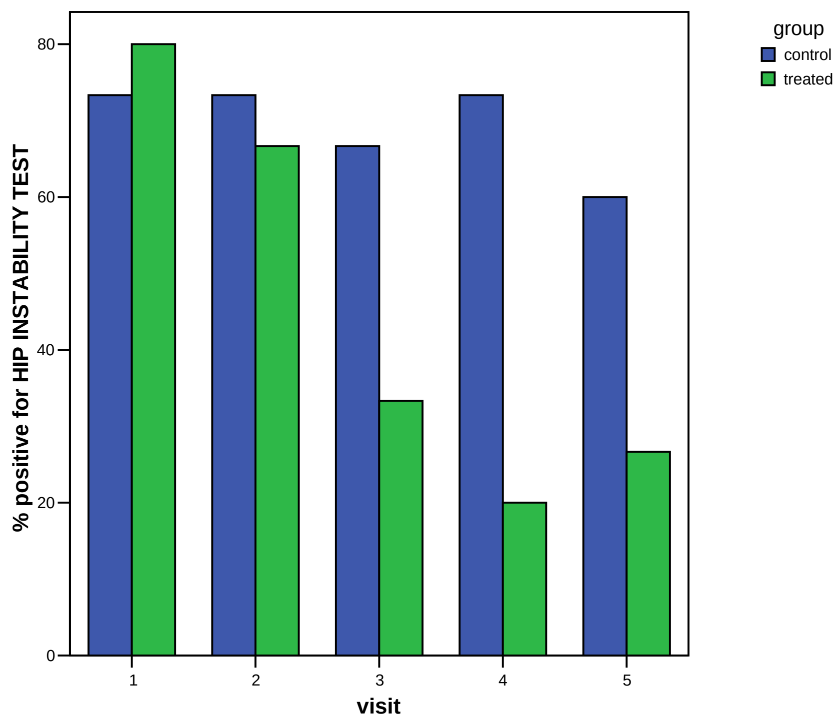


Figure 6: Hip instability test by visit by treatment group

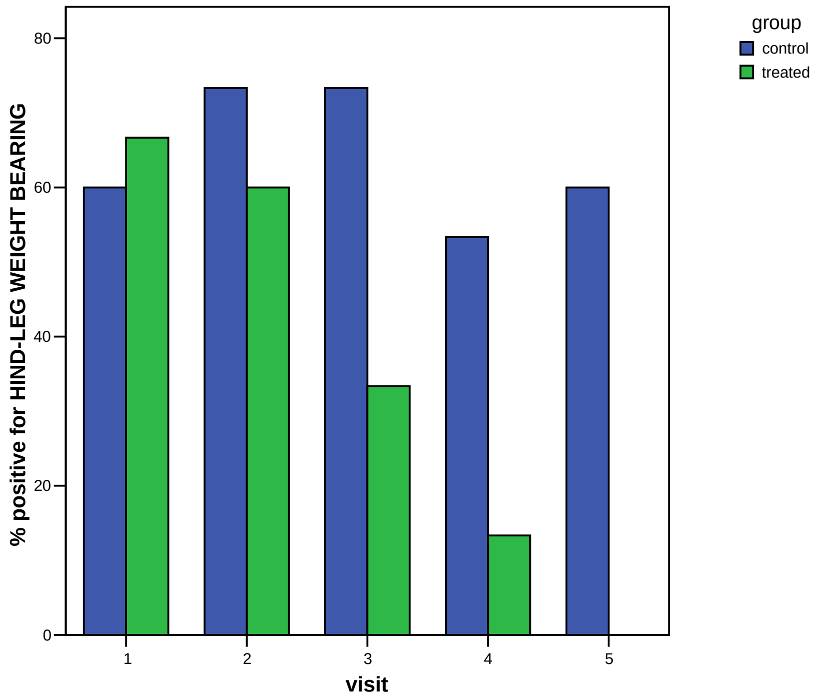


Figure 7: Hind-leg weight bearing test by visit by treatment group

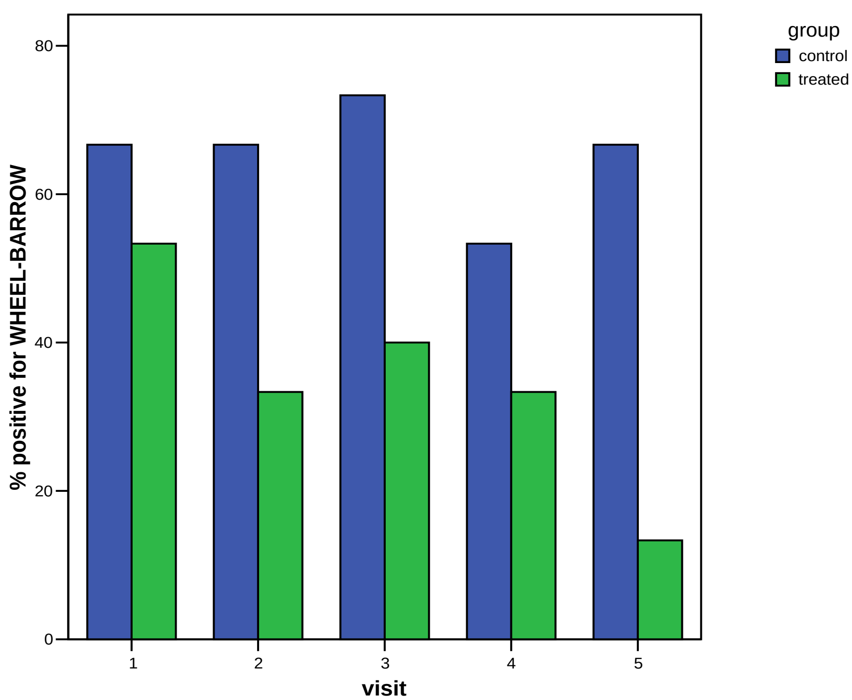


Figure 8: Wheel-barrow test by visit by treatment group

Total orthopedic score:

There was a highly statistically significant time by group interaction for total orthopedic score (p = 0.004). Examination of **Figure 9** shows that the treated group means decreased at a significantly faster rate and to a greater extent than the control group.

Table 17: Repeated measures ANOVA for total orthopedic score

Factor	Statistic	p value
Time (visits)	Wilk's lambda 0.428	<0.0001
Time*group (interaction)	Wilk's lambda 0.548	0.004
Group	F=12.281	0.002

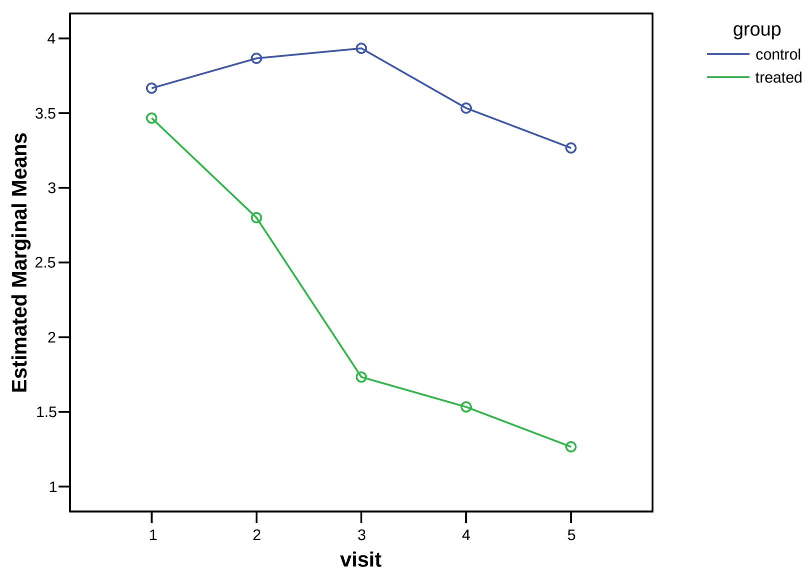


Figure 9: Mean total orthopedic score over time by group

The goniometer readings were normally distributed quantitative variables, thus repeated measures ANOVA was used to compare the treatment groups and examine the presence of a time effect, or a time by group interaction.

a. Right hind leg extension

For right hind leg extension there was a marginally significant change over time (p = 0.054) but no difference in this change between the control and treated groups (p = 0.383). Thus both groups changed marginally significantly over time. Examination of **Figure 10** shows that this change was a slight increase in goniometer values in the control group over time and not much change in the treated group from their baseline values.

Table 18: Repeated measures ANOVA for right hind leg extension

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.699	0.054
Time*group (interaction)	Wilk's lambda 0.782	0.173
Group	F=0.786	0.383

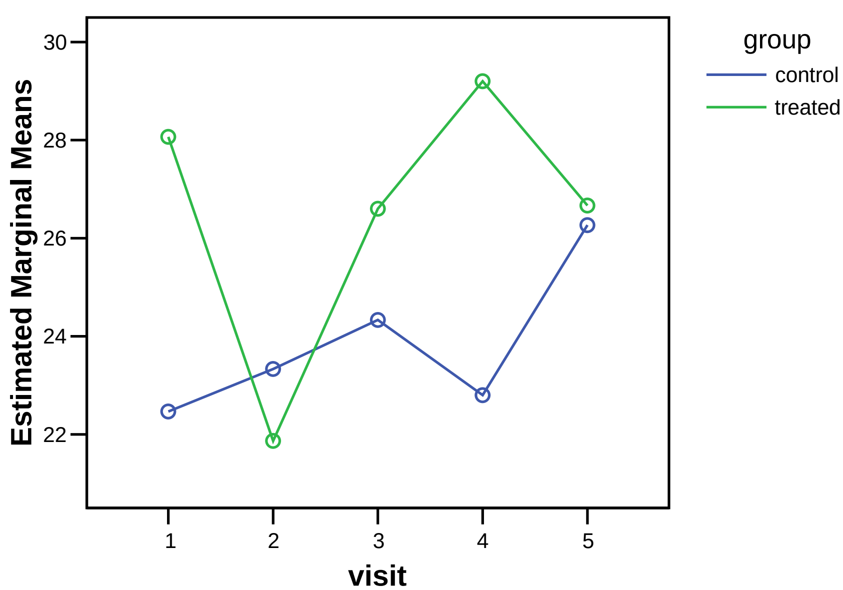


Figure 10: Mean right hind leg extension by visit by treatment group

b. Right hind leg abduction

There was a significant interaction between time (visits) and group for right hind leg abduction (p= 0.043). Examination of **Figure 11** shows that the two groups had different patterns over time. The treated group values increased over time while the control group did not change over time.

Table 19: Repeated measures ANOVA for right hind leg abduction

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.722	0.076
Time*group (interaction)	Wilk's lambda 0.684	0.043
Group	F=0.882	0.356

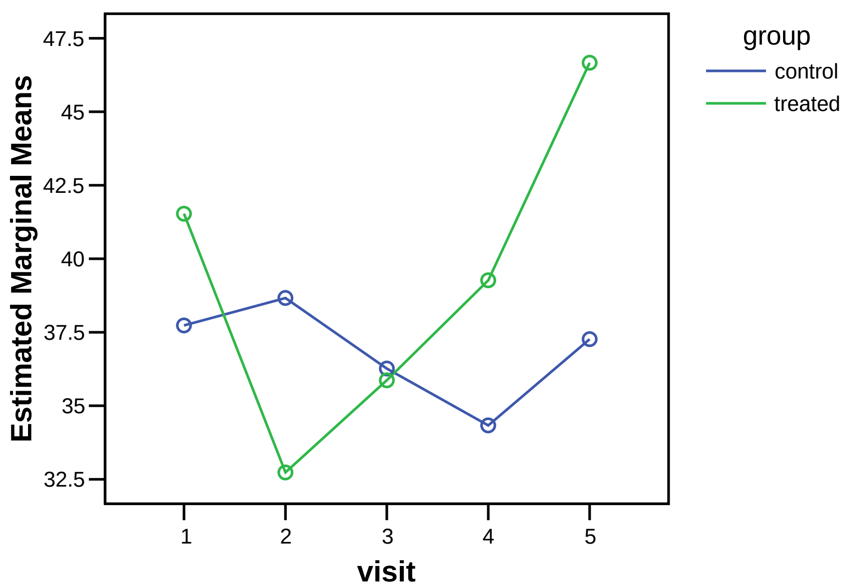


Figure 11: Mean right hind leg abduction by visit by treatment group

c. Left hind leg extension

There was no significant change over time or between treatment groups for left hind leg extension. **Table 20** shows the results of the repeated measures ANOVA and **Figure 12** shows this graphically. Both groups values initially decreased up to visit 3 and then increased their values so that by visit 5 they were above their baseline values. This happened to a slightly greater extent in the treated than the controls, but it was not significantly different.

Table 20: Repeated measures ANOVA for left hind leg extension

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.771	0.150
Time*group (interaction)	Wilk's lambda 0.925	0.733
Group	F=0.325	0.573

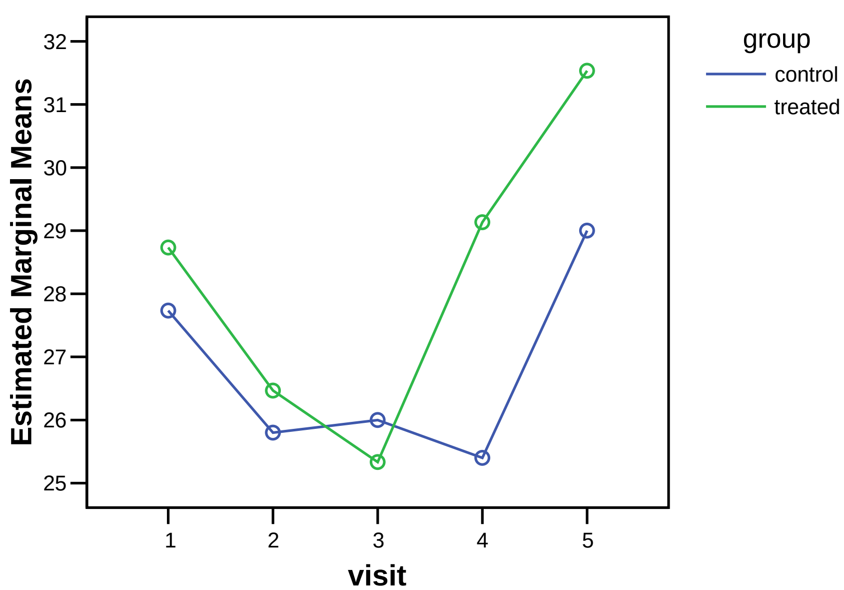


Figure 12: Mean left hind leg extension by visit by treatment group

d. Left hind leg abduction

There was no significant change over time, nor between the treatment groups for left hind leg abduction. **Figure 13** shows that the values decreased to visit 4 and then increased steeply in both groups to visit 5. This increase was steeper in the treated dogs but not statistically significantly different than the control dogs (p=0.967).

Table 21: Repeated measures ANOVA for left hind leg abduction

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.755	0.121
Time*group (interaction)	Wilk's lambda 0.821	0.276
Group	F=0.002	0.967

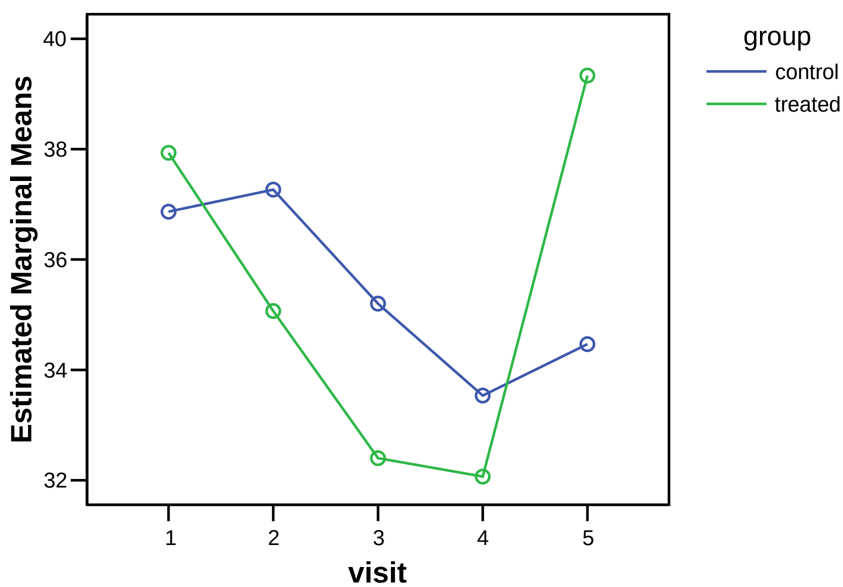


Figure 13: Mean left hind leg abduction by visit by treatment group

Table 22: Repeated measures ANOVA for thigh measurements

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.888	0.543
Side	Wilk's lambda 0.972	0.373
Time*side (interaction)	Wilk's lambda 0.684	0.043
Group	F=0.013	0.911
Time*group (interaction)	Wilk's lambda 0.904	0.621

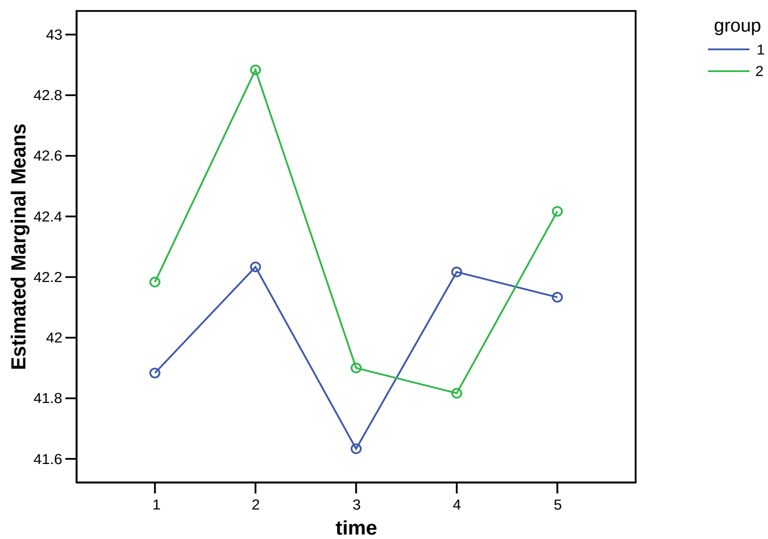


Figure 14: Mean thigh girth measurements by visit by treatment group

Table 23: Repeated measures ANOVA for calf measurements

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.879	0.503
Side	Wilk's lambda 0.941	0.195
Time*side (interaction)	Wilk's lambda 0.897	0.588
Group	F=0.390	0.537
Time*group (interaction)	Wilk's lambda 0.854	0.395

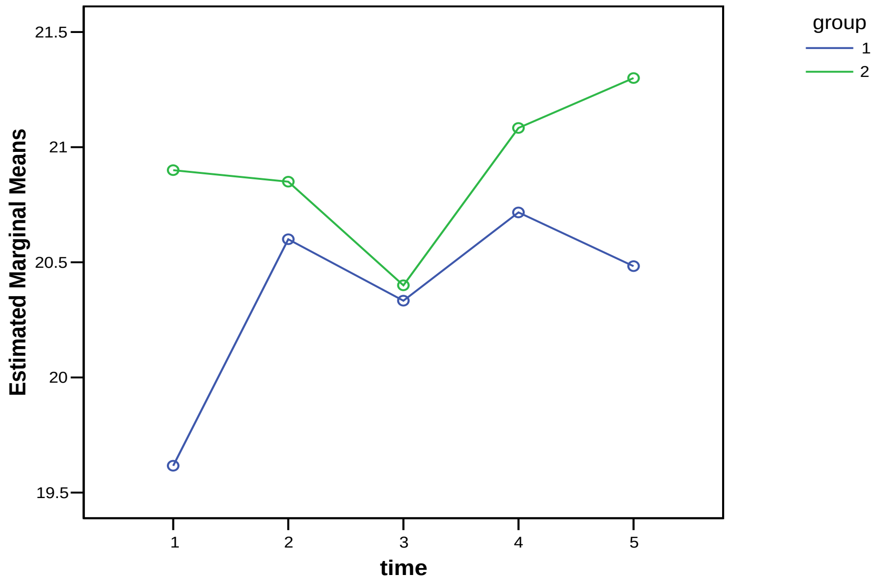


Figure 15: Mean calf girth measurements by visit by treatment group

Thigh and calf measurements were each compared by side (left or right), controlling for treatment group, to assess if there were significant changes in one side more than another using repeated measures ANOVA.

a. Thigh circumference

There was a significant time by side interaction, i.e. the changes over time were not the same in both sides. **Figure 16** shows the change in thigh measurements over time by side (1 = right, 2=left). The right side increases over time while the left side does not.

Table 24: Repeated measures ANOVA for thigh measurements

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.888	0.543
Side	Wilk's lambda 0.972	0.373
Time*side (interaction)	Wilk's lambda 0.684	0.043
Group	F=0.013	0.911

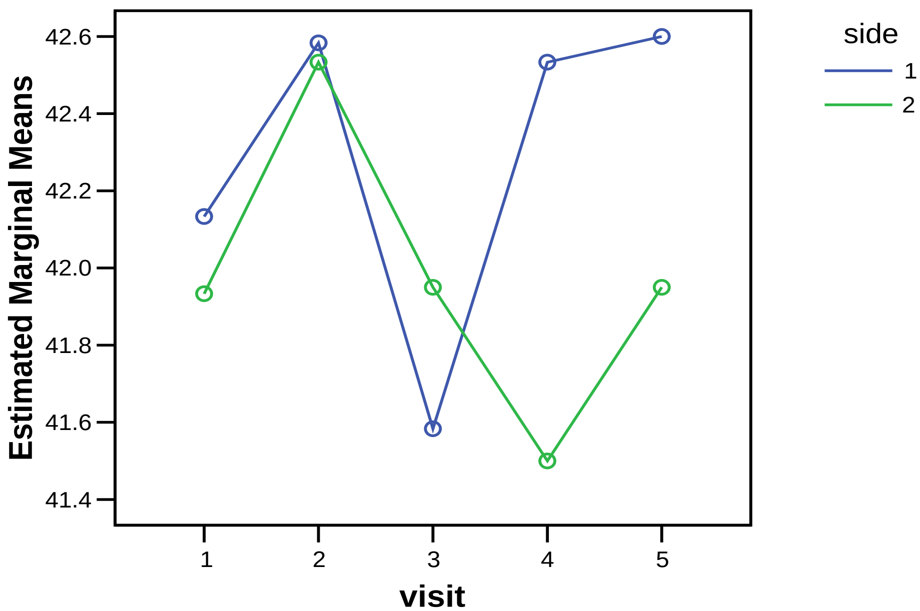


Figure 16: Mean thigh measurements by visit and side

b. Calf circumference

There was no significant difference between the sides or over time for calf. **Figure 17** shows that both sides increased over time slightly to similar extents (side 1= right, 2=left).

Table 25: Repeated measures ANOVA for calf measurements

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.879	0.503
Side	Wilk's lambda 0.941	0.195
Time*side (interaction)	Wilk's lambda 0.897	0.588
Group	F=0.390	0.537

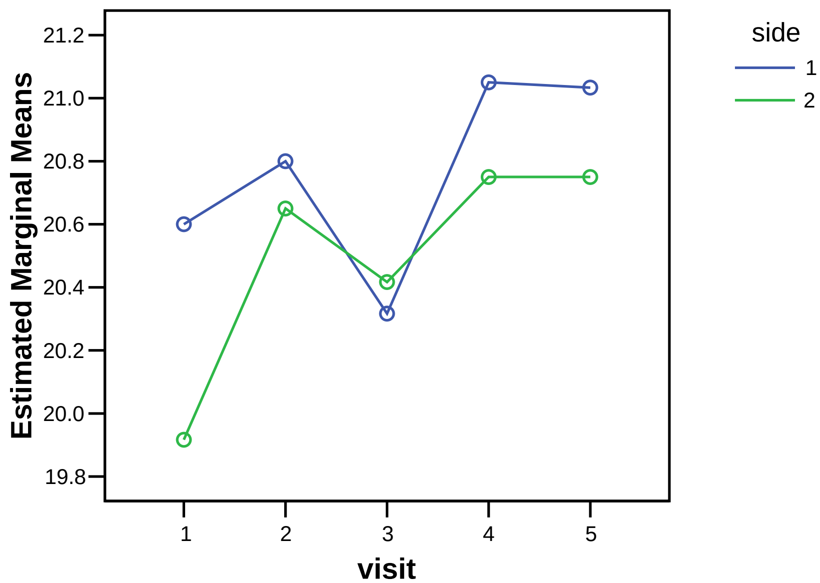


Figure 17: Mean calf measurements by visit and side

There was no difference at baseline in weight bearing of the back legs between the treatment groups as determined by t-test (p = 0.768 for right and p = 0.494 for left). This is shown in **Table 26**.

Table 26: Comparison of mean tarsal diameter by treatment group

	group	N	Mean	Std. Deviation	Std. Error Mean	p value
Right back tarsal	control	15	6.7333	1.29376	.33405	0.768
	treated	15	6.9000	1.74438	.45040	
Left back tarsal	control	15	6.700	1.1464	.2960	0.494
	treated	15	7.000	1.2247	.3162	

There was also no significant difference in weight bearing between the breeds at baseline (p = 0.064 for right and p = 0.11 for left). Results of the Kruskal –wallis test for breed are shown in **Table 27**.

Table 27: Kruskal-Wallis test for median tarsal diameter in left and right sides by breed

	breed	N	Mean Rank	Kruskal-Wallis p value
Right back tarsal	Africanus	2	1.75	0.064
	Boerboel	2	26.25	
	Bulldog	2	20.00	
	Bullmastiff	1	28.50	
	German Shepherd	6	10.42	
	Golden Retriever	2	20.00	
	GSD X	2	14.75	
	Labrador	7	14.07	
	Great Pyrenees	1	28.50	
	Rhodesian Ridgeback	1	5.50	
	Rottweiler	2	16.50	
	St. Bernard	1	30.00	
	White Shepherd	1	13.00	
	Total	30		
Left back tarsal	Africanus	2	2.00	0.111
	Boerboel	2	25.50	
	Bulldog	2	18.50	
	Bullmastiff	1	25.50	
	German Shepherd	6	10.50	
	Golden Retriever	2	19.50	
	GSD X	2	15.25	
	Labrador	7	15.43	
	Great Pyrenees	1	29.00	
	Rhodesian Ridgeback	1	8.00	
	Rottweiler	2	16.00	
	St. Bernard	1	30.00	
	White Shepherd	1	8.00	
	Total	30		

Right and left tarsal diameter was compared over time between the treatment groups using repeated measures ANOVA.

a. Right tarsal diameter

There was no significant change over time nor between the groups for right tarsal diameter. **Figure 18** shows that neither of the two groups changed much over time, although the values for the treated group were at most time points higher than those for the control group.

Table 28: Repeated measures ANOVA for right tarsal diameter

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.906	0.631
Time*group (interaction)	Wilk's lambda 0.848	0.369
Group	F=0.054	0.818

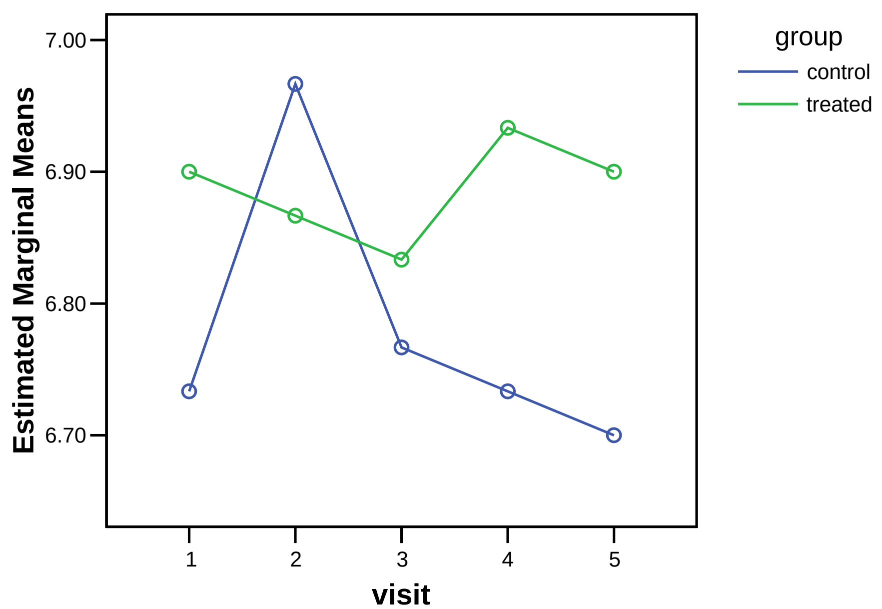


Figure 18: Mean right tarsal diameter by group over time

b. Left tarsal diameter

There was no difference between the groups and over time for left tarsal diameter. **Figure 19** shows that neither group changed over time but the treated group's values decreased and then increased back up to their baseline, while the control group values increased and then decreased back down to their baseline values.

Table 29: Repeated measures ANOVA for left tarsal diameter

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.981	0.973
Time*group (interaction)	Wilk's lambda 0.923	0.721
Group	F=0.209	0.651

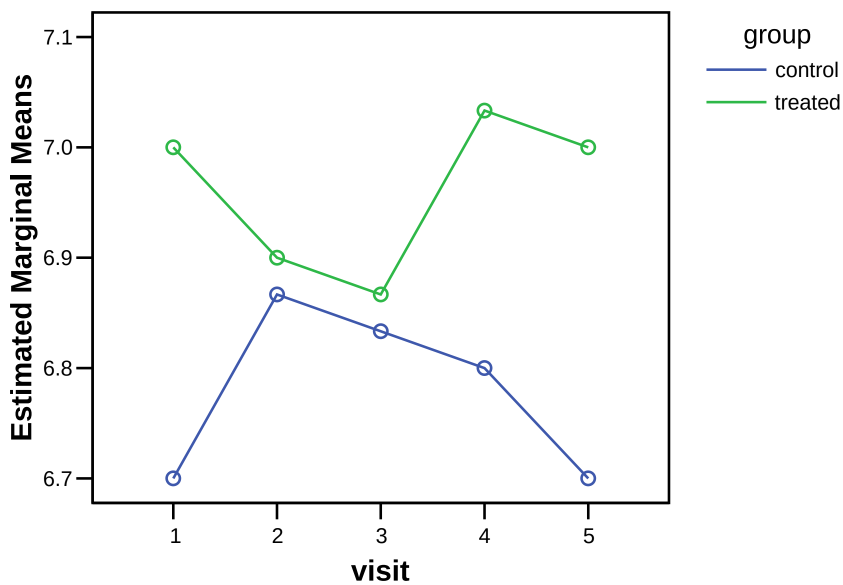


Figure 19: Mean left tarsal diameter by group over time

Disability index total score

Mann- Whitney test was used to assess if there was a significant difference between the baseline total disability index scores between the treatment groups. There was no significant difference (p = 0.412), although the treated group had slightly higher median disability scores at baseline than the control group.

Repeated measures ANOVA was used to assess change in total disability index score over time by group. Results are shown in **Table 30**. There was a significant change over time in all subjects, irrespective of which group they were in. **Figure 20** shows that scores decreased over time in both treated and control dogs to the same extent.

Table 30: Repeated measures ANOVA for total disability index score

Factor	statistic	p value
Time (visits)	Wilk's lambda 0.525	0.002
Time*group (interaction)	Wilk's lambda 0.954	0.874
Group	F=0.506	0.483

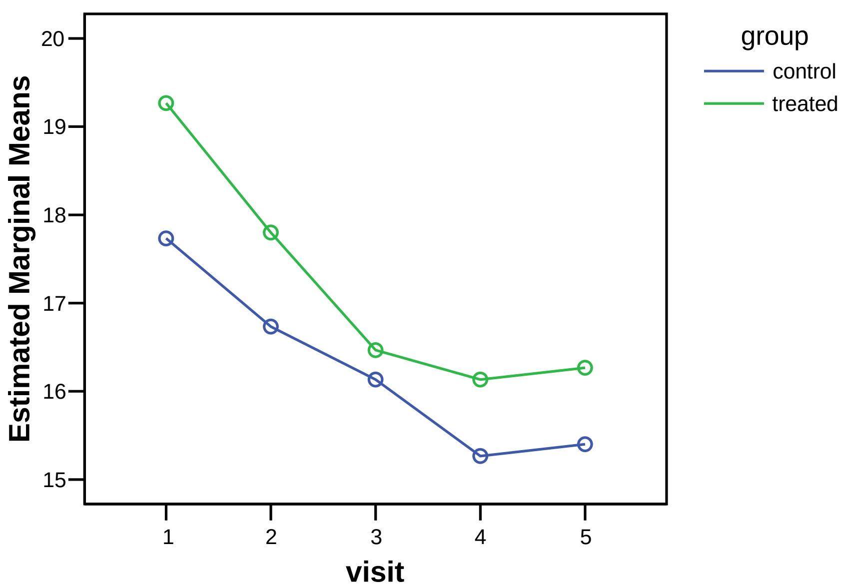


Figure 20: Mean total disability index score over time by group

At baseline there was no significant difference in disability index score between the breeds of dogs (p = 0.159). The median score at baseline for each is shown in **Figure 21**.

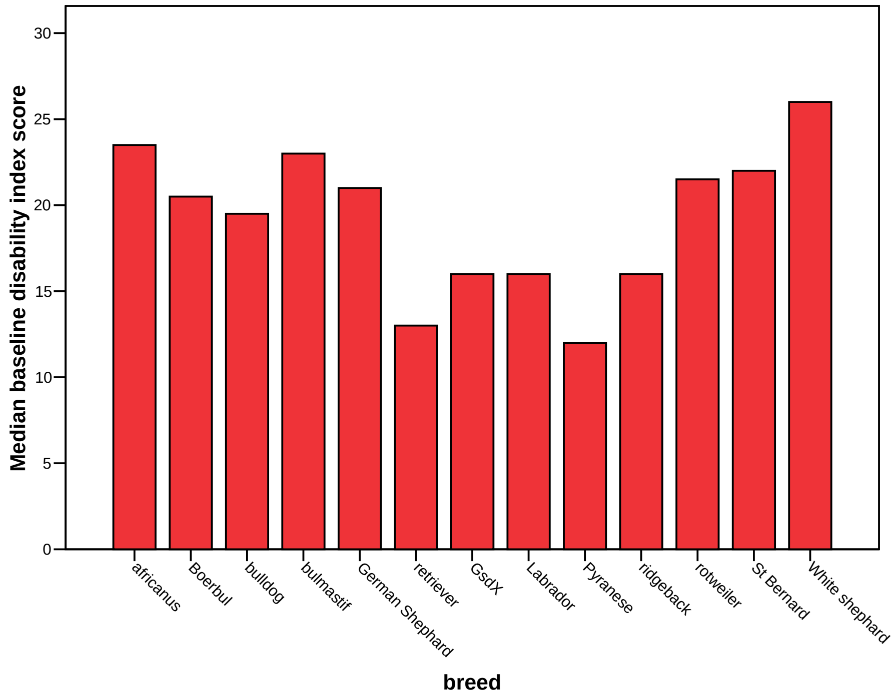
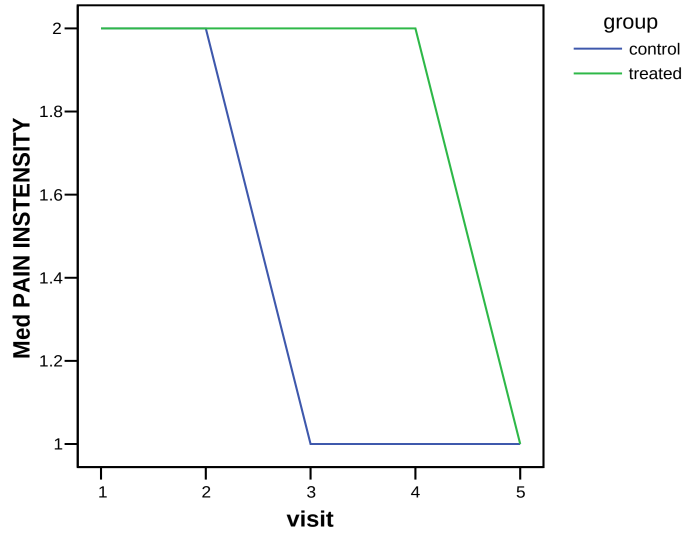
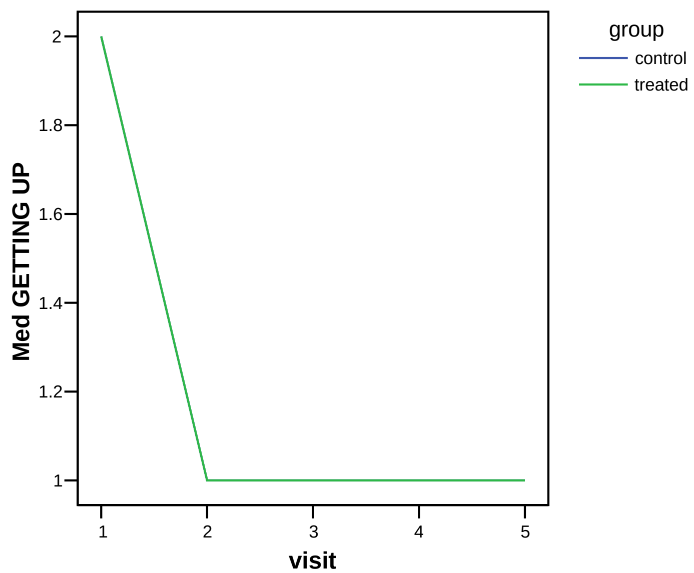
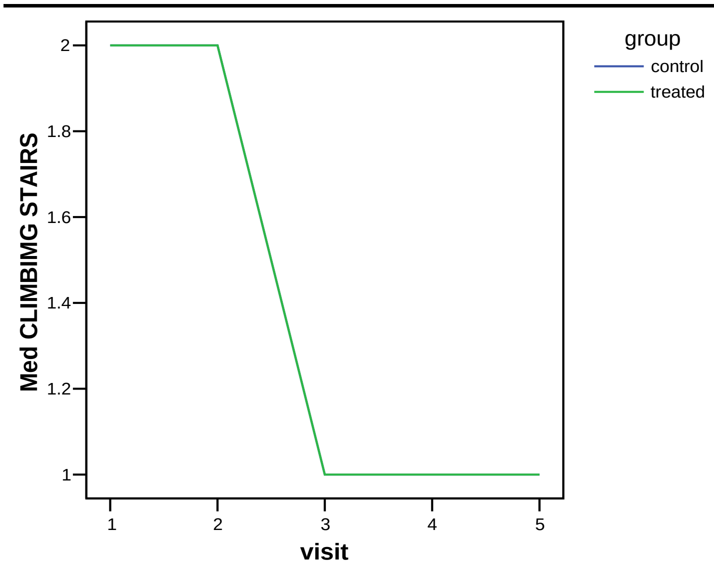


Figure 21: Median disability index score at baseline by breed

Plots of median values for question by treatment group over time were done to determine which questions showed changes over time and by group (**Figures 22-31**). Some questions did not differ by group although they decreased over time (getting up, climbing stairs, jumping up) and some questions did not change over time or by group (exercise, appetite and lying down). The other questions all showed a median decrease over time, which occurred at different rates in the two groups. Pain intensity decreased faster in the control group than the treated group, reaction to cold weather decreased faster in the treated group than the controls, recreation ability decreased in the controls but not in the treated group, and reaction to pain remained the same in the controls and treated dogs.


Med PAIN INSTENSITY
2
1.8
1.6
1.4
1.2
1
1
2
3
4
5
visit
group
control
treated


Med GETTING UP
2
1.8
1.6
1.4
1.2
1
1
2
3
4
5
visit
group
control
treated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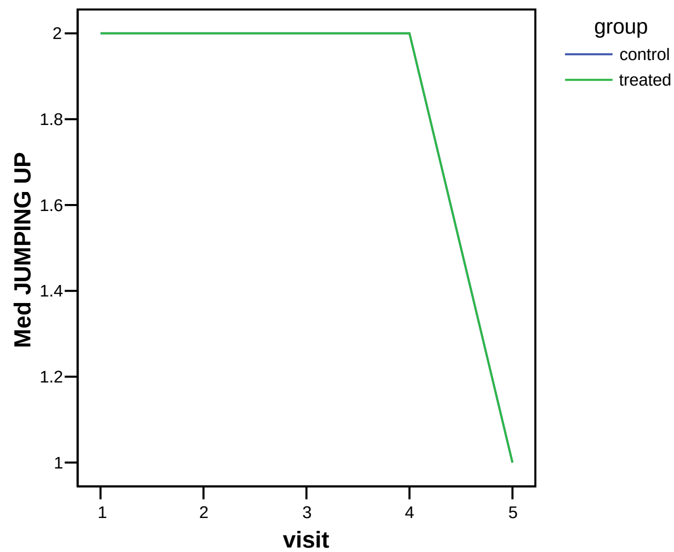

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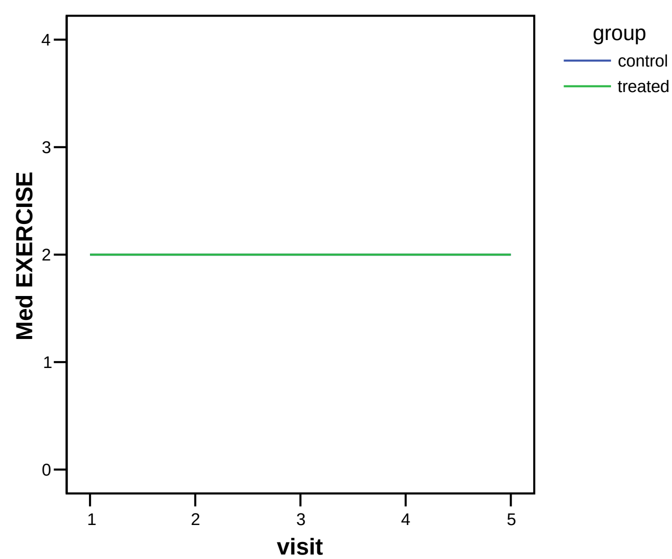

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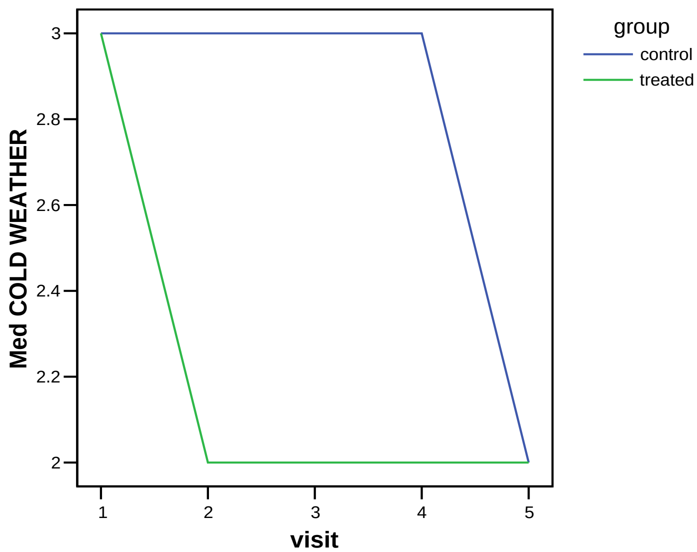
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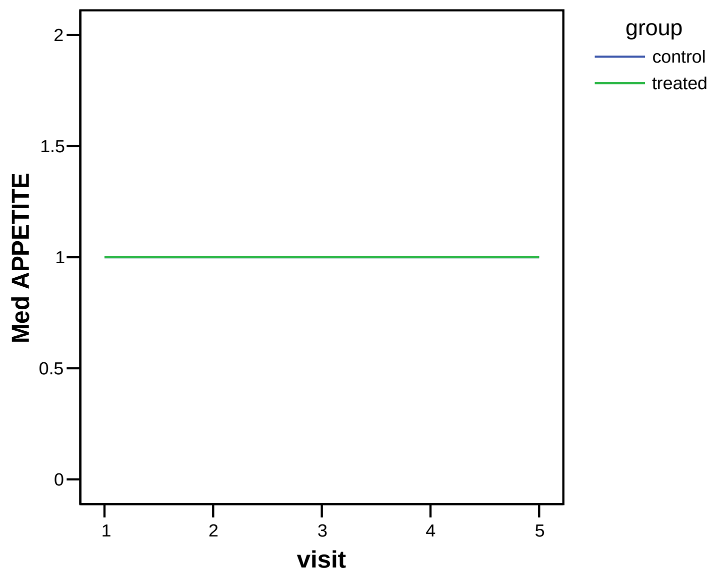
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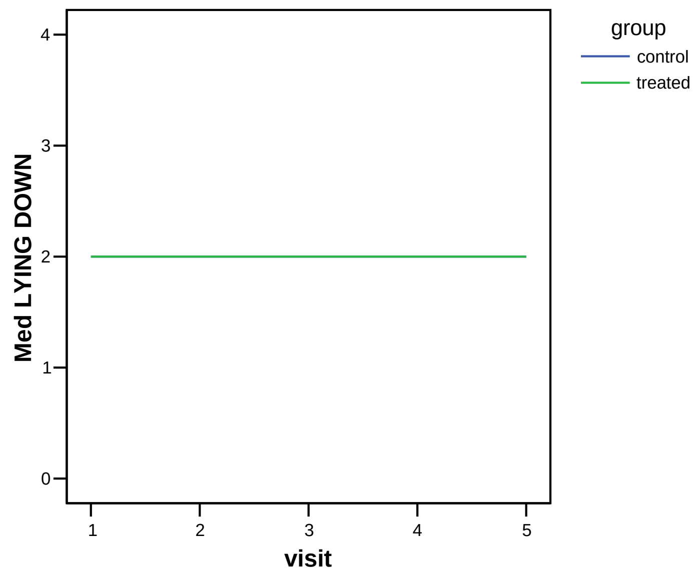
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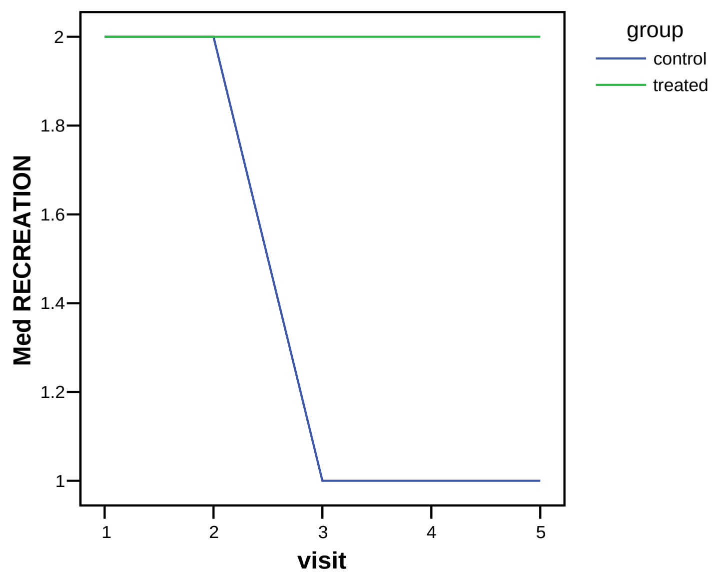
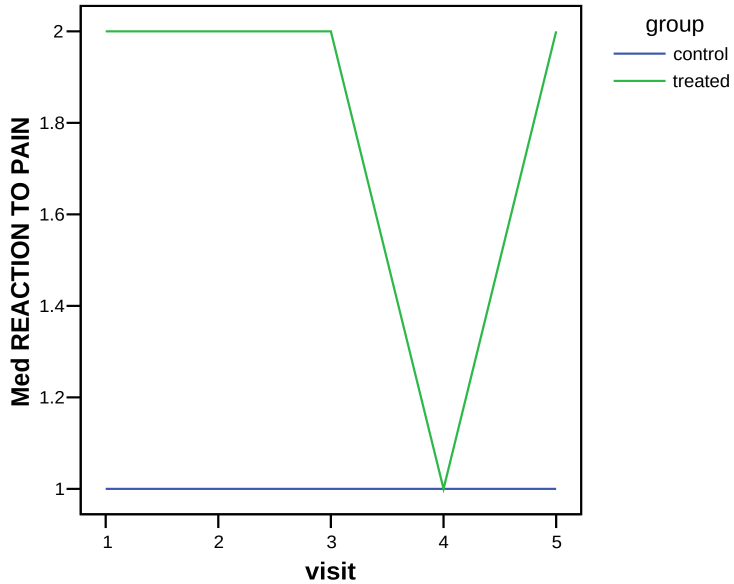

group
control
treated
Med RECREATION
visit



Figures 22-31: Median responses to individual questions on disability index form by group

Correlation between subjective and objective findings

At baseline, the total score for orthopedic tests and total disability index score were correlated using Pearson's correlation coefficient. There was a significant positive correlation between the two scores ($p = 0.004$, $r = 0.514$), thus as objective scores increased, so did subjective scores. This is shown in **Figure 32**. However, this correlation did not persist throughout the follow up visits.

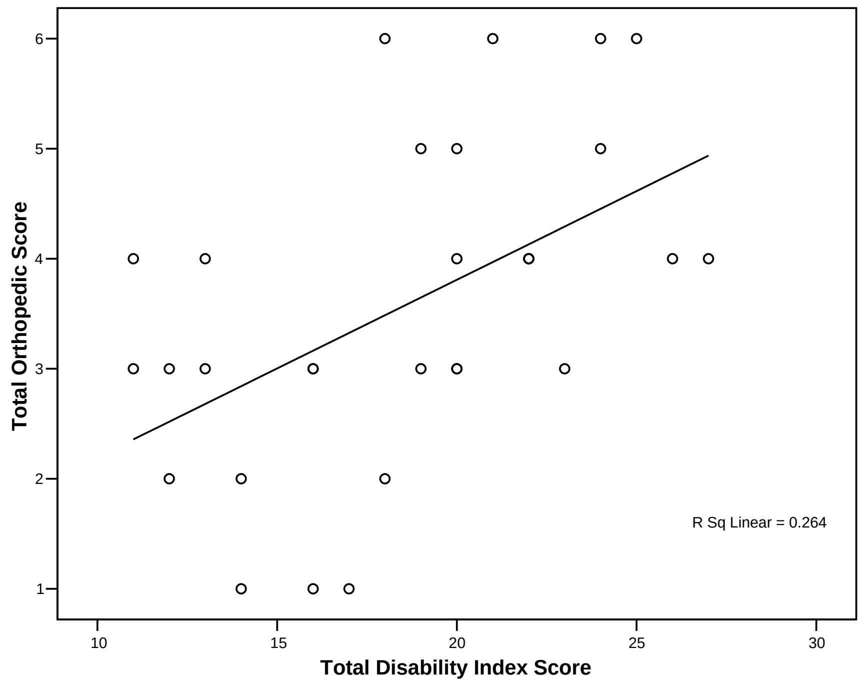


Figure 32: Correlation between objective orthopedic score and subjective disability index score at baseline

4.5 SUMMARY OF FINDINGS

For the orthopedic tests for lumbar extension and possibly wheelbarrow, the treatment had a significant protective effect, in that the treated group showed less positive tests. The total orthopedic score showed significant treatment effect. The treatment group's orthopedic scores decreased significantly faster and to a greater extent than the control group. Goniometer readings did not differ significantly between the groups over time, except in the case of right hind leg abduction, where the treated group increased significantly faster than the control group. Right side thigh measurements increased over time to a greater extent than left side thigh measurements, regardless of treatment group of the dog. Tarsal diameter did not change significantly over time nor between the groups.

Both groups showed a significant decrease over time with regard to the total disability index score, but there was no difference in this change over time between the groups. Of the individual questions, only reaction to cold weather showed a faster decrease in treated dogs than in control dogs. The majority of the questions remained unchanged over time in both groups or changed at the same rate in both groups. Thus there is no overwhelming evidence that the intervention is superior to the control except in two of the orthopedic tests. Dogs in both groups seemed to improve to the same extent over time.

CHAPTER FIVE

DISCUSSION

5. DISCUSSION

5.1 INTRODUCTION

This chapter is concerned with the discussion of the objective and subjective data obtained from the four consultations and two-week follow up consultation.

Objective data: motion palpation findings, orthopedic tests, goniometer readings, hind-leg girth measurements, and hind foot tarsal diameter measurements.

Subjective data: Veterinary approved canine hip dysplasia disability index form.

Control: Glucosamine Sulphate

The results are discussed in two sections:

Intra-group results: The evaluation of the data obtained from all 5 consultations represents the efficacy of the treatment regime. A comparison of this data from the fourth consultation to the fifth consultation two-weeks later, gives an indication if the treatment efficacy was maintained. Finally, a comparison of the first through fifth consultations indicates to what extent the clinical condition of canine's returned to baseline values.

Inter-group results: The data from the first consultation from both treatment and control groups was assessed to determine if there was any difference between the two groups in terms of objective and subjective findings. A comparison of the 5 consultations for both groups indicates which treatment regime was more effective. A comparison of the two-week follow up consultations from both groups indicates which treatment regime maintained a more favorable response to the treatment.

5.2 DEMOGRAPHIC DATA

Demographically, the canines in both groups were similar, in terms of age, gender and weight distribution, which helped to standardize results.

The most common breed affected by hip dysplasia, which presented in this study was the Labrador, followed by the German Shepherd. If however, the German Shepherd breed and German Shepherd cross- breed dogs were combined, the most commonly affected breed would have been the German Shepherd type dog. This is shown in Table 1. These figures are not necessarily an indication of the breed risk for South Africa, but may indicate the popularity of these breeds within the geographical location of this study. There is however a cross correlation between the two.

The breeds most commonly seen in this study were in keeping with OFA (orthopedic foundation for animals) data of breed risk for hip dysplasia from 1974-1998, as cited by Kirberger (1999). The most commonly affected breed is the Bulldog 71.4%, followed by the St. Bernard 47.1%, Bullmastiff 26.4%, Golden Retriever 21.6%, Rottweiler 21.2%, German Shepherd Dog 19.9%, Bouvier Des Flandres 16.5%, Labrador Retriever 13.2%, Great Pyrenees 9.9%, and Rhodesian Ridgeback 6.8%. The above pertain to American bred dogs, and may not necessarily correlate with the popularity of breeds in South Africa.

The average age of the symptomatic canine in this study was five years of age. See Table 2.

The average weight of dogs participating in this study was thirty kilograms, see Table 3, which is within normal limits of the breed types seen in this study, as they were mostly large breed dogs, except for the St. Bernard and Great Pyrenees, which are considered giant breeds.

At the initial consultation it was established if any of the canines favored one leg over the other. Exactly half of the canines in this study favored one leg. Table 4.

The owner's were asked at the initial consultation if any of the canines showed a change in gait. Results showed 83.3% of canines in this study had a change in gait related to their hip dysplasia. Table 5. This change however, was not influenced significantly by the weight of the canine. In fact, the slightly lighter canines showed more of a change in gait, which is opposite to what one would assume to be the case. Results of this correlation can be seen in Table 6. Almost all of the breeds showed a change in gait, but this may have been due to the low sample size within each breed type. Figure 1.

At the initial consultation, owner's were asked if their canines were able to squat. The results in Table 7 show that 63.3% of canines in this study could squat when relieving themselves. Neither age nor weight affected their ability to do so, Table 8. It was not possible to ascertain a statistical estimate of the breed type, which battled to squat, due to low sample size in the breed categories. Trends however are shown in Figure 2.

5.3 MOTION PALPATION FINDINGS

The number of subluxations found, at the initial consultation, was correlated to the age and weight of the canines within the study population. The number of subluxations ranged from 2 to 8, with most canines having 4 subluxations at baseline. There was no significant difference in this number, between breed type, Table 10.

Subluxations were located along the entire length of the spine, from the cervical region through to the lumbar region. Coccygeal subluxations were not assessed for, as differing breeds had varying numbers of coccygeal vertebrae. These were therefore not included, in order to help standardize results. The most common regions to be affected throughout the study, were the thoracic and cervical regions, followed by the sacro-iliac joints, and lumbar vertebrae. Results can be seen in Table 11. It cannot be concluded however, that these findings are limited to dysplastic canines, as no comparison was made with a non-dysplastic population.

It can be noted that the median number of subluxations in the treated group, as compared with the control was less at all consultations apart from the initial. This indicates that instrument manipulation is effective in reducing the number of subluxations. Table 14.

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5.4 INTRA-GROUP COMPARISON

5.4.1OBJECTIVE DATA

5.4.1.1Orthopedic tests

5.4.1.1.1 Total orthopedic score

Both groups showed improvement trends in overall total orthopedic score.

Group 1, the control group showed a decline in total orthopedic score between the first and fifth consultation. A slight decline in overall total orthopedic score between the fourth and fifth consultation – the two-week follow up, was also noted. An overall slight improvement trend was noted, showing the expected benefits of glucosamine sulphate supplementation, within the duration of the study. Figure 9.

Group 2, the treatment group showed a large improvement between the first and fifth consultations, with regards to total orthopedic score, Figure 9. The difference noted between group 2 initial baseline total orthopedic score and the score at the end of the fifth consultation, showed a large statistical significance, with a p value of 0.004, Table 17, indicating a substantial benefit from instrument manipulation with glucosamine sulphate supplementation.

5.4.1.1.2 Lumbar facet test

Canines in group 1 showed a slight improvement between consultation 1 and consultation 5, for the lumbar facet test. This improvement was noted between the first and second, and the fourth and fifth consultations. There was a slight improvement overall, however nothing of statistical significance. Figure 3.

Group 2 canines, showed a large improvement trend between the first and last consultation, with regards to this test. Large improvement trends were noted between consultations two, and three, and again four and five.

5.4.1.1.3 Lumbar extension test

Group 1, showed an initial increase in positive scores, between the first and third consultations, indicating an increase in pain response to this test, and then an improvement between consultations three and five. Figure 4.

The treatment group showed a statistically significant improvement (p= 0.002) in their lumbar extension test scores, with no positive pain responses by the fourth consultation. Table 16. An increase in positive scores was noted after the two-week follow up period. Figure 4.

5.4.1.1.4 Hip abduction test

The control group canines showed a similar score for this test throughout the study, with only a slight improvement noted between the fourth and fifth consultations, as seen in Figure 5. Perhaps this was due to not performing this pain response test over the two-week period.

The canines in the treatment group showed a decline in pain response steadily throughout the study period with regards this test, until a slight increase between the fourth and fifth consultations. This increase is possibly due to the fact that the canines received no instrument manipulation throughout this two-week follow up period. Interestingly enough, there was also an increase in the median number of thoracic and sacroiliac subluxations for the treatment group, during this time. Table 13. This increase in subluxations decreases spinal movement causing more positive pain responses for hip abduction. Figure 5 shows these trends.

5.4.1.1.5 Hip instability test

Hip instability test scores showed little variation for the control group canines throughout the study. Figure 6.

Group 2 canines showed improvement trends regarding the test scores, with most of this occurring between consultations two and three. The overall improvement may be due to the decreased number of subluxations as a result of the instrument manipulation. Table 14. A decrease in subluxations probably results in increased vertebral and pelvic motion, with less stress being placed on the involved hip, during testing. Figure 6.

5.4.1.1.6 Hind-leg weight bearing test

Figure 7 reveals group 1 canines showing an initial increase in positive test scores, between the first and second consultations, followed by a decline at the fourth and an increase again at the fifth consultation.

Group 2 canines show a steady decline in test scores from the first to the fifth consultation. Figure 7.

5.4.1.1.7 Wheel-barrow test

Figure 8 shows similar results for the control group throughout the study, with a slight increase in scores between the second and third consultations. This may be due to the aggravation of symptoms, caused by this test, which involves lumbar extension whilst hip weight bearing. The decrease at the fourth consultation may be due to a mobilization effect, from repeating the test at each consultation, or the glucosamine sulphate supplementation starting to take effect at around twenty days, as discussed in the literature. The rise in positive pain responses at the final consultation is possibly due to immobility- from a lack of performing this test during the two-week follow up period.

The treatment group canines show a decline in test scores between consultations one and five, with only a slight increase at the third consultation. Overall Figure 8 shows a significantly large improvement trend between the first and last consultations, with a p value of 0.056. Table 16. This could be attributed to the decrease in subluxations (Table 14) and an improvement in biomechanics, resulting in less pain responses to testing.

5.4.1.1 GONIOMETER READINGS

5.4.1.1.1 Right hind leg extension

Group 1 shows a slight increase in goniometer readings over time, indicating an improvement trend, but nothing of statistical significance. Figure 10.

Figure 10 show not much change in group 2 values from their baseline readings.

5.4.1.1.2 Right hind leg abduction

Group 1, Figure 11, shows a pattern of increase in goniometer readings followed by a decrease, indicating a decline in right hind leg abduction.

Group 2 showed a significant decrease in right hind leg abduction, followed by an increase to above baseline readings. Figure 11.

5.4.1.2.3 Left hind leg extension

Group 1, initially showed a decrease in range of motion in left hind leg extension, followed by an increase to above baseline readings. Figure 12.

Group 2 shows similar trends, with an initial decrease followed by an increase to above baseline. Figure 12.

5.4.1.2.4 Left hind leg abduction

Figure 13 shows that values for the control group initially increased between consultations one and two, then decreased until the fourth consultation, indicating a decline in range of left hind leg abduction, with a slight improvement seen at the last consultation.

Group 2 shows an initial decline in range of motion of left hind leg, followed by an improvement to above baseline between the fourth and fifth consultations. Figure 13.

5.4.1.3 THIGH AND CALF GIRTH MEASUREMENTS

5.4.1.3.1 Thigh circumference measurements

Group 1 thigh circumference measurements, showed erratic changes throughout the study, however measurements taken at the fifth consultation were above baseline readings at the initial consultation. One would expect this overall hypertrophy as symptoms dissipated with glucosamine sulphate supplementation. Figure 14.

Group 2 thigh circumference measurements, were also erratic throughout the study. However, overall thigh circumference hypertrophy was demonstrated for the treatment group. These results could be attributed to either the positive effects of the glucosamine sulphate supplementation and/or the benefits of the instrument manipulation. Figure 14.

Difficulties incurred with data collection and human error would probably account for the observed measurement irregularities in thigh girth.

Neither group showed changes that were statistically significant.

5.4.1.3.2 Calf circumference measurements

Group 1 showed an improvement trend in calf girth measurements between the first and final consultations. Trends show an initial increase, followed by a slight dip at the third consultation, which again increases at the fourth and dips again slightly at the two –week follow up consultation. Figure 15.

Group 2 canines show increased final calf circumference measurements when compared to those at baseline. Trends in this group show an initial decrease in girth readings, up until the third consultation, followed by an increase until the final consultation. Figure 15.

Difficulties incurred with data collection and human error would probably account for the observed measurement irregularities in calf girth, throughout this study.

Neither group showed changes that were statistically significant.

5.4.1.4 TARSAL DIAMETER

5.4.1.4.1 Right tarsal diameter

Group 1 did not show much change over time with regards to right tarsal diameter, Figure 18.

Group 2 showed little change over time, however, tarsal diameters were at most time points higher than those in the control group, Figure 18. This correlates with larger thigh and calf diameters found in the treatment group. Figures 14 and 15.

5.4.1.4.2 Left tarsal diameter

The control group's values for left hind tarsal diameter, increased and then decreased back down to baseline, Figure 19. This is unexplained, but correlates with the change in thigh and calf measurements of the control group. Figures 14 and 15.

The treatment group 's values decreased and then increased back up to their baseline. Figure 19. There is no correlation or explanation for these variations in the readings. Figures 14 and 15.

5.4.2 SUBJECTIVE DATA

5.4.2.1 Disability Index Total Score

Both groups showed a significant change in total disability index score over time, Figure 20.

5.5 INTER-GROUP COMPARISON

5.5.1 OBJECTIVE DATA

5.5.1.1 Orthopedic Tests

5.5.1.1.1 Total orthopedic score

Both groups showed improvement trends in overall total orthopedic score, however, there was a highly statistically significant time by group interaction (p=0.004) for the total orthopedic score. Table 17. The treatment group means decreased at a significantly faster rate, and to a greater extent than the control group.

5.5.1.1.2 Lumbar facet test

The odds ratio was higher in the treatment group than the control, showing that the treatment group was more likely to show a pain response to the lumbar facet test than the control group. The treatment groups baseline readings were however, initially higher than the control. Figure 3.

5.5.1.1.3 Lumbar extension test

This test showed a statistically significant improvement in the treatment over control group, over time (p=0.002). Table 16. Group 2 canines were 92.25 less at risk for showing a positive pain response to this test.

5.5.1.1.4 Hip abduction test

Figure 5 shows an improvement trend for the treatment group over time, not much variation in the control group.

5.5.1.1.5 Hip instability test

Figure 6, shows a larger improvement trend for group 2 canines, than control group, indicating that the treatment group canines are less likely to show a positive test result.

5.5.1.1.6 Hind-leg weight bearing test

Figure 7 shows a decrease in treatment group canines for positive test results, indicating an improvement over the time of the study, whereas the control group canines return to their baseline readings.

The overall improvement may be due to the decreased number of subluxations as a result of the instrument manipulation. Table 14. A decrease in subluxations probably results in increased vertebral and pelvic motion, with less stress being placed on the involved hip, during testing. Figure 7.

5.5.1.1.7 Wheel-barrow test

The treated canines were 66.7% less likely to show a positive test result, with marginal statistical significance (p=0.056). Table 16. This indicates that the treated dogs exhibiting less subluxations, Table 14 showed greater pain free range of motion, and were more willing to stand on their hind legs, and showed less pain in doing so.

5.5.1.2 GONIOMETER READINGS

5.5.1.2.1 Right hind leg extension

Table 15 shows no difference in change in goniometer readings for the right hind leg in extension, between the control and treated groups. This can be seen in Figure 10.

5.5.1.2.2 Right hind leg abduction

Table 16 shows a significant improvement in the treatment group over time, for right hind leg abduction (p=0.043). This can be seen in Figure 11. The treatment group improved over time, while the control group did not change from baseline at the end of the study.

5.5.1.2.3 Left hind leg extension

The treatment group increased to a slightly higher level above baseline than did the control group, for left hind leg abduction, Figure 12, however this increase was not statistically significant (p=0.573).

5.5.1.2.4 Left hind leg abduction

The increase in goniometer readings for left hind leg abduction was steeper than that for the control group, Figure 13. This difference in gradient however was not statistically significant. Table 21.

5.5.1.3 THIGH AND CALF GIRTH MEASUREMENTS

5.5.1.3.1 Thigh circumference measurements

Both groups showed similar trends throughout the study, the only difference being group 1 canines showed an increase in thigh girth measurements between the third and fourth consultations, followed by a decrease between the fourth an fifth. This was opposite to what was seen in group 2 canines, as they showed a decrease in measurements between the third and fourth consultations, and a steeper increase between the fourth and fifth. However, there was no statistical difference.

5.5.1.3.2 Calf circumference measurements

With regards to calf circumference measurements, the two groups showed opposing trends, with the control group showing a steep improvement, followed by a decrease in girth readings at the third consultation, which increased at the fourth and decreased again at the fifth. This is in contrast with group 2 canines as they showed a slight decrease initially followed by more of a decrease at the third consultation, and then an increase in these readings until the end of the study. However, there was again no statistical significance to these changes.

5.5.1.4 TARSAL DIAMETER

There was no difference at baseline between the treatment and control groups in weight bearing of the hind legs, Table 26. There was also no difference in weight bearing between the breeds, Table 27.

5.5.1.4.1 Right tarsal diameter

Although neither group improved significantly over time, the values for the treated group were at most points in time, higher than those of the control, indicating a possible increase in hind leg weight bearing in these canines. Figure 16.

5.5.1.4.2 Left tarsal diameter

There was no difference between the groups, and over time, for left tarsal diameter, Figure 16.

5.5.2 SUBJECTIVE DATA

5.5.2.1 Disability Index Total Score

There was no significant difference between the two groups for the overall total disability index scores. However, the treatment group showed higher median disability scores at baseline than did the control group. Figure 18.

5.6 DISCUSSION OF THE OBJECTIVE AND SUBJECTIVE DATA

From the statistical data it can be seen that both groups improved during the period of this study, in terms of both objective and subjective clinical findings. It can therefore be concluded that both treatment protocols were effective in managing the symptoms of canine hip dysplasia. The instrument manipulation group showed significantly fewer positive pain responses to the lumbar extension and possibly wheelbarrow tests.

Goniometer readings did not differ significantly between the groups over time, except in the case of right hind leg abduction, where the instrument manipulation group increased significantly faster than the control group.

Right side thigh measurements increased over time to a greater extent than left side thigh measurements, regardless of treatment group of the dog.

Tarsal diameter did not change significantly over time, or between the groups.

Both groups showed a significant decrease over time with regard to the total disability index score, but there was no difference in this change over time between the groups. Of the individual questions, only reaction to cold weather showed a faster decrease in treated dogs than in control dogs. The majority of the questions remained unchanged over time in both groups or changed at the same rate in both groups.

Thus there is no overwhelming evidence that the intervention is superior to the control except in two of the orthopedic tests, the lumbar facet test and the wheelbarrow test. This makes sense, in that manipulation of the facet joints results in relief of residual pain and symptoms (Gatterman, 1990). This would explain why the instrument manipulated canines showed less pain responses, when the lumber spine was placed into extension with these two tests. The other tests also show this, however, not with statistical significance. If the sample size was larger, more conclusive results could be obtained.

Dogs in both groups seemed to improve to the same extent over time.

5.7 STUDY LIMITATIONS

5.7.1 Sample Size

It is recognized that the sample size of only thirty canines, utilized for this research was possibly too small, to draw any accurate and statistically significant conclusions form. Unfortunately this was all that time and budgetary constraints would allow for.

Of the thirty canines entered into this study, all thirty completed the full course of consultations and treatments.

5.7.2 PROBLEMS WITH THE OBJECTIVE DATA

The goniometer readings must be viewed with discretion as user error may have contributed to variations in terms of the authenticity and accuracy of the hip ranges of motion.

Errors on the part of the researcher may have included placement of the axis at exactly the same location at each consult and errors in reading the degrees off the goniometer.

Problems with goniometer readings with regards the canines included the canine not allowing the researcher to extend or abduct the hip fully, without resistance or guarding.

The canine's activities may have resulted in changes in subluxation levels, or additional subluxations. This along with an increase in muscle stiffness and pain, due to these activities may account for unexplained variations in goniometer readings.

5.7.3 PROBLEMS WITH THE SUBJECTIVE DATA

As this study was not blinded in any way, it was possible that the owners of the canines tried to please the researcher by subjectively reporting improvement at successive consultations. This problem however, would have occurred within both groups and therefore, should not have prejudiced one group more than another. Some owners expressed a degree of difficulty when filling in the questionnaire, as they did not have stairs, or were unsure on how to determine their canine's pain.

The major limitation of this study was the small sample size of 30 canines, but financial and time constraints did not allow for a larger one.

5.8 COMPARISON OF THE RESULTS

To this authors knowledge, no study involving spinal instrument manipulation as a management for symptomatic canine hip dysplasia of any description could be found in journals, text books or the internet, thus it was impossible to make direct comparisons to other research studies.

CHAPTER SIX

RECOMMENDATIONS AND CONCLUSION

6. RECOMMENDATIONS AND CONCLUSION

6.1 RECOMMENDATIONS

This study should be repeated using a larger sample size, so that a more accurate conclusion can be drawn from the derived information. A follow-up study at six months, one year and two years might help establish how effective the treatment is over a longer period.

Inclusion of non-dysplastiic canines into this trial, as a third control group, would help determine whether motion palpation findings were limited to dysplastic canines only, or if these non-dysplastic canines show similar trends.

More reliable instruments, with less of a margin for human error would help obtain more accurate objective measurements. Difficulty in this study was encountered when measuring degrees of range of motion with the goniometer on the canines, as they were sometimes less than compliant. Measuring thigh and calf hind leg circumferences also proved to be a little tricky, with the exact same placement of the tape measure at each consultation.

The use of a force plate, or similar would greatly increase the accuracy of determining how much weight was being transferred through each of the hind legs. Budgetary constraints, however was the deciding factor with respect to the instruments used in this particular study.

With regards to the subjective results, obtained through the veterinarian approved canine hip dysplasia disability index form (appendix D), it would decrease irregularities if the same person could fill in the questionnaire at each visit. Preferably the person who spends the most time with the canine, as it was noticed that opinions varied slightly between family members, with regards the same canine.

In future studies of this nature, the canines' diets, exercise levels, age, and environments should be taken into account during patient selection, as weight and strenuous exercise obviously aggravate the symptoms of hip dysplasia. These recommendations are to standardize any further results, and not to prefer any treatment group to another.

If possible efforts should also be made to standardize the manner in which the glucosamine supplement was given, i.e. with or without food, the time of day the dosage was given, whether the correct dosage was in fact given, and if the course was completed.

An exclusion criterion of this study was the need for any other treatment, the canine might require as a result of any illness or other complaint, in order to reduce any discrepancies within the results. This however was also impossible to control, as the owner had to be relied on to inform the researcher of any such treatment/s.

If any canines had needed other medications for any reason, whilst partaking in this study, a washout period would have been required. To the best of this researchers knowledge, however, none of the canines received any other treatments whilst partaking in this study. If they had, this washout period would have been discussed with a qualified veterinary surgeon, as there are half-life differences in medications, for different breeds. These range from approximately 35 – 72 hours (Aiello, 1998).

6.2 CONCLUSION

The results of this study indicate that both treatment protocols were effective in managing the symptoms of canine hip dysplasia, over a short-term period. At a confidence level of 95%, the treatment group showed a statistically significant improvement ($p = 0.004$), over the control group, with regards to the total orthopedic scores of both groups, in terms of objective clinical findings.

The other objective findings did not differ significantly between the two groups over time. This may however be due to sample size, and duration of the study.

In terms of subjective clinical findings, both groups showed a significant decrease in mean total disability score, over time with regards to the disability of the canines.

Thus there is no overwhelming evidence that instrument manipulation is superior to glucosamine sulphate in managing the symptoms of canine hip dysplasia, except with regards to the orthopedic tests.

We already know that the use of glucosamine sulphate is indicated in the management of symptomatic canine hip dysplasia, so it would be the clinical judgement of the consulting doctor as to whether the use of instrument manipulation alone, or combined with glucosamine sulphate would be beneficial at this stage.

In conclusion, this pilot study has demonstrated that the use of instrument manipulation is as effective as the use of glucoamine sulphate supplementation for the short-term management of symptomatic canine hip dysplasia. Further studies of larger sample sizes and of a longer duration need to be conducted to determine the full benefit if this intervention, in providing these canines with relief.

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APPENDIX A

COVERING LETTER FOR OWNER'S OF DOGS ENTERING THIS STUDY

Research title: A pilot controlled trial to determine the effectiveness of instrument manipulation in symptomatic canine hip dysplasia.

Dear owner,

Welcome to my research study in canine hip dysplasia. I am investigating the effectiveness of instrument manipulation in the management of symptomatic canine hip dysplasia.

Hip dysplasia is a genetically transmitted condition, which results in degeneration of the hip joint. This in turn causes pain and disability. Hip dysplasia is very common, and although not curable, the symptoms can be relieved.

All treatment will be free of charge and will be conducted at the Westville Veterinary Hospital.

The group to which your dog will be / has been assigned will be / has been randomly predetermined. In order for your dog to participate in this study the following will be required:

a. The dog must be previously diagnosed with hip dysplasia (x-rays are essential).
b. If the dog is suffering from any systemic or unrelated local pathology, it may not be included in this study.
c. If any contraindications to manipulation are suspected on examination, the dog may not be included in this study.
d. Conditions other than canine hip dysplasia will not be treated in this study.
e. The dog may not receive any analgesics or any form of manual therapy (including massaging painful areas) throughout the duration of this study.
f. A consent form will be required to be filled out, by you, the owner prior to treatment.

Dogs will receive four treatments/consultations within a two-week period and a two-month follow-up evaluation. The dog will remain in the study as long as you commit to the appointment schedule. Please answer the above questions as accurately as possible.

Yours sincerely

Tamara Meuwese

APPENDIX B

INFORMED CONSENT AND COMPLIANCE FORM

To be completed in duplicate by owner

Title of research project**:**
A pilot controlled trial to determine the effectiveness of instrument manipulation in symptomatic canine hip dysplasia.

Name of Supervisors:
Dr. A.D. Jones, M.Dip:Chiropractic Tel (031) 9034467
Dr. S.J. Wimberley, Veterinary Surgeon and Tel (031) 2678000
Dr. J. Perkin, M.Tech: Chiropractic Tel (0731881826)

Name of research student: Tamara Meuwese Tel (0825575398**)**

Introduction:
Hip dysplasia is the most common cause of orthopaedic problems in dogs. Veterinary treatment at present is currently limited to the use of anti-inflammatory drugs and surgery.

Although sufficient documented research exists regarding the efficacy of chiropractic treatment in humans there is a limited amount of research on the efficacy of veterinary chiropractic techniques in South Africa.

The role of manipulation as an additional component in the management of symptomatic canine hip dysplasia (CHD) needs to be investigated.

Purpose:
Therefore the purpose of this study is to determine the effectiveness of an activator instument manipulation technique in the management of symptomatic CHD, against Glucosamine sulphate- an effective natural supplement.

Procedures:
Participation of dogs entering this study will be required for one month's duration, regardless of which group they are assigned to.

At the initial consultation, your dog will be assessed for his/her suitability for this study. He/she will then be randomly assigned to either group 1 or group 2, and you the owner will be required to read and sign:

- A covering letter (Appendix A) and
- A letter of informed consent (Appendix B), which must be signed, indicating that you are entering your dog into this study and will abide by its conditions.

Information will be required from you the owner, regardless of which group your dog is in. This information applies to the following:

- Canine new-patient form (Appendix C) and
- Veterinarian approved canine hip dysplasia disability index form (Appendix D)

Your dog will then undergo a series of orthopaedic tests, measurements and motion palpation, non-of which is invasive, to assess his/her disease status at the time of the initial consult (Appendix E)

If your dog is in group1,he/she will receive glucosamine supplementation for the full four weeks, and will be required to receive four consultations (including the initial) within a two-week period, and will be required to come in for a two-week evaluation. At all of these consultations the following forms will be completed:

- Veterinarian approved canine hip dysplasia disability index form (Appendix D)
- Objective data and treatment form (Appendix E)

Your dog will receive a free glucosamine sulphate supplement for the duration of one month, whilst participating in this study.

If your dog is in group2, he/she will receive four treatments (including the initial) within a two-week period, and will be required to come in for a two-week evaluation.

At all of these consultations, the following forms will be completed:

- Veterinarian approved canine hip dysplasia disability index form (Appendix D)
- Objective data and treatment form (Appendix E)

After being recorded, the canines' in-group 2 will receive manipulations according to findings, by means of an Activator adjusting device.

Risks/Discomforts:

- Dogs are at minimal risk, as those that are included in this study involve a low level of contra-indications due to veterinary clearance before entering the study
- Glucosamine sulphate is an unscheduled natural supplement, which has minimal side effects (e.g. mild diarrhoea), which is counteracted, by giving the capsules together with food.
- As a result of the manipulation, transient stiffness and/or mild discomfort, for treatment duration or shortly thereafter, has been reported in human studies and is hypothesised to be a similar risk factor in dogs, due to the similarities of the physiology of the joints.

Benefits:

Nutritional supplementation with glucosamine sulphate has been shown as a safe, effective and natural alternative to NSAIDS for the symptoms of inflammatory joint conditions in both humans and animals. It not only helps to alleviate the symptoms, but also slows the progression of the disease, and helps repair previous damage to the affected joint.

Dogs with hip dysplasia compensate for their loss of hip stability, and pain during walking by shifting balance. This results in areas of increased stress on the spine, and muscle spasm. Activator manipulation aims at releasing this muscle spasm by returning the joints to normal ranges of motion. Less movement will then be required from the affected hip, which will help delay degeneration of that hip.

Aims of the above treatments are:

To alleviate pain
Slow down or prevent secondary arthritic changes, and
Provide maximum function of the hip joint

Reasons as to why you may be withdrawn from this study without your consent:

Your dog may be removed from this study for the following reasons:

If your dog becomes ill and requires veterinary treatment
If your dog's condition worsens and he/she requires medication and/or surgery
If your dog becomes aggressive during the duration of the study and as a
result is unable to be examined without placing anyone at risk.

Remuneration:
You will not receive any remuneration for participating in this study, from myself, or any member of the Westville Veterinary Hospital

Costs of the study:
If your dog qualifies for this study, all consultations pertaining only to this study will be free of charge. Please note that this includes no outside treatment provided by anyone at the Westville Veterinary Hospital.

Confidentiality:
All documentation and information pertaining to this study is confidential and will be used purely for academic purposes.

Research related injury:
The risk of research related injury is minimal as all dogs participating in this study will be assessed beforehand for suitability, and the treatments used are low-risk.

Persons to contact regarding problems or queries:

Researcher: Tamara Meuwese 0825575398
Westville Veterinary Hospital – Dr. S.J. Wimberley (031) 2678000

Please circle the appropriate answer.

1.Have you read the covering letter for this research? YES/NO

2.Have you had opportunity to ask questions regarding this study? YES/NO

3.Have you received satisfactory answers to your questions? YES/NO

4.Have you had an opportunity to discuss this study? YES/NO

5.Have you received enough information about this study? YES/NO

6.Who have you spoken to? ______________________________________

7.Do you understand the implications of your involvement in this study, as well as the
implications of the involvement of your canine? YES/NO

8.Do you understand that you are free to withdraw your canine from this study- a) at any
time
b) without having to give a reason for withdrawing your canine, and
c) without affecting the future health care of your canine? YES/NO

9.Do you voluntarily agree to allow your canine to participate in this study? YES/NO

Please ensure that the researcher takes you through each step of the covering letter in order that you understand everything before giving your consent.

Patient / Canine Name: ______________________

Guardian / Owner Name: _____________________Signature:____________

Witness Name:_____________________________Signature: ____________

Research Student Name:_____________________Signature:____________

Date:_____________________________________

APPENDIX C

CANINE NEW-PATIENT FORM

NAME:	OWNER:
GROUP:	
DATE OF BIRTH:	ADDRESS:
AGE:	
SEX:	
BREED:	TEL:
HEIGHT:	
WEIGHT:	VET:
COLOUR:	DATE:

Discipline: (if any, eg. Herding, field trials, agility, etc.)

____

Conditioning: □ Poor □ Good □ Excellent
□ Overweight □ Underweight

Comments:

____

History of past illness/surgery:

____

Case History of Hip Dysplasia:

____

Functional ability:

- Does the canine favour one leg over another? Yes No
  If yes, which one?
- Is there any change in the canine's gait (walking style)? Yes No
  If yes, what is the change, e.g., collapsing, limping, bunny hopping etc.?
- Can the canine squat when going to the toilet? Yes No
- If no, what do you attribute this to?

APPENDIX D

Veterinarian Approved Canine Hip Dysplasia Disability Index Form

Patient Name: Date:

Owner Name: Group:

This questionnaire has been designed to give the veterinarian information as to how your dog's pain has affected his ability to manage in everyday life. Please answer every section and mark in each section only ONE box as it applies to your dog. We realize you may consider 2 or more of the statements in any one section may relate to your dog, but please only mark the box, which most closely describes your dog.

Section 1-Pain Intensity Based on the dog's functional ability or lack thereof, how would you as the owner rate the dog's pain? ❑ The dog has no pain at the moment. ❑ The dog's pain is mild at the moment. ❑ The dog's pain is moderate at the moment. ❑ The dog's pain is severe at the moment.	Section 6-Cold Weather ❑ The dog's pain appears to be unaffected by the weather. ❑ The dog's pain does not appear to be worse in cold, damp weather. ❑ The dog's pain appears to be moderately worse in cold, damp weather. ❑ The dog's pain appears to be severe in cold, damp weather.
Section 2-Difficulty in getting up from a sitting or lying position ❑ The dog can get up without it appearing to cause any extra pain. ❑ The dog can get up but it appears to cause extra pain. ❑ The dog avoids getting up, as the pain it causes is severe. ❑ The dog can't get up without assistance.	Section 7-Appetite ❑ The pain the dog experiences does not appear to have affected his/her appetite. ❑ The pain the dog experiences appears to have decreased his/her appetite slightly. ❑ The pain the dog experiences appears to have greatly decreased his/her appetite. ❑ The dog won't eat at all as he/she is in too much pain.
Section 3-Climbing Stairs ❑ The dog can climb stairs without any visible pain. ❑ The dog can climb stairs but it appears to cause mild discomfort. ❑ The dog can climb stairs but it appears to cause moderate pain. ❑ The dog can't climb stairs as a result of the pain it causes. ❑	Section 8- Lying down ❑ The dog gets up frequently and runs around. ❑ The dog lies down without moving much whilst lying down. ❑ The dog moves intermittently or changes position often, in order to get into a less painful position. ❑ The dog moves around a great deal whilst lying down, or does not move at all, both due to pain.
Section 4-Jumping up ❑ The dog jumps up without the appearance of any pain. ❑ The dog jumps up but it appears to cause mild discomfort. ❑ The dog jumps up but it appears to cause moderate pain. ❑ The dog can't jump up as a result of the pain it causes.	Section 9- Recreation ❑ The dog is able to engage in all recreation activities without the appearance of pain. ❑ The dog is able to engage in all recreation activities with the appearance of pain. ❑ The dog is able to engage in some but not all of his usual recreation activities due to pain. ❑ The dog is unable to do any recreation activities due to pain.
Section 5 –Exercise ❑ The dog can exercise strenuously without limping afterwards. ❑ The dog can exercise mildly without limping afterwards. ❑ The dog can't exercise without limping afterwards. ❑ The dog doesn't want to exercise at all as a result of the pain it causes.	Section 10- Reaction to pain How does your dog respond if accidentally "bumped"? ❑ He/she takes no notice. ❑ He/she winces, then carries on as normal. ❑ He/she winces and moves away from the painful stimulus. ❑ He/she reacts in some defensive manner, i.e., growls, snarls, snaps or bites.

APPENDIX E

OBJECTIVE DATA AND TREATMENT FORM

Patient name: ____________________

Date: ___________________________

Group: __________________________

PERMISSION TO TREAT (PTT)

VISIT NUMBER	1	2	3	4	FOLLOW-UP
VETERINARY SIGNATURE					

MOTION PALPATION

VISIT NUMBER	1	2	3	4	FOLLOW-UP
MOTION PALPATION FINDINGS					

ORTHOPEADIC TESTS

VISIT NUMBER	1	2	3	4	FOLLOW-UP
LUMBAR FACET CHALLENGE					
LUMBAR EXTENSION TEST					
HIP ABDUCTION TEST					
HIP INSTABILITY TEST					
HIND-LIMB WEIGHT BEARING TEST					
WHEEL-BARROW TEST					
ORTHOPEDIC SCORE					

GONIOMETER READINGS

VISIT NUMBER	1	2	3	4	FOLLOW-UP
R.HIND-LEG EXTENSION					
R.HIND-LED ABDUCTION					
L.HIND-LEG EXTENSION					
L.HIND-LEG ABDUCTION					

HIND-LEG GIRTH MEASUREMENTS

VISIT NUMBER	1	2	3	4	FOLLOW-UP
R.HIND-LEG THIGH GIRTH					
R.HIND-LEG CALF GIRTH					
L.HIND-LEG THIGH GIRTH					
L.HIND-LEG CALF GIRTH					

HIND-FOOT TARSAL DIAMETER

VISIT NUMBER	1	2	3	4	FOLLOW-UP
R.HIND TARSAL DIAMETER					
L.HIND TARSAL DIAMETER					

VISIT NUMBER	1	2	3	4	FOLLOW-UP
TREATMENT					

APPENDIX F

DOES YOUR DOG SUFFER FROM HIP DYSPLASIA?

Chiropractic treatment is currently being researched at the Westville Veterinary Hospital.Should your canine qualify for this research, all consultations and treatments pertaining to this study will be

free of charge

Contact

Tamara Meuwese

at the following number:

082 557 5398

APPENDIX G

FOCUS GROUP

The following is a list of the focus group which was approached to pilot the Veterinarian Approved Canine Hip Dysplasia Disability Index Form. The following people were asked to read both an existing Neck Disability Index Questionnaire and the Canine Hip Dysplasia Disability Index Form (appendix D), and provide comments and recommendations.

Contributors:

- Canine owner and registered breeder
- Canine owner, registered breeder and committee member of the Natal Gundog Club
- Canine owner and registered breeder
- Canine owner, registered breeder and dog judge
- Canine owner
- Chiropractor
- Chiropractor
- Veterinary Surgeon
- Veterinary Surgeon
- Veterinary Nurse

Recommendations regarding the Canine Hip Dysplasia Disability Index Form:

- Replace questions on sleeping with lying down, as often unable to assess canine's sleep pattern.
- Add something regarding pain, in terms of change in temperament.

Suggestions were also made regarding the effect of the canine's disease state in terms of its ability to squat whilst relieving itself, and any changes in its gait due to the disease process. These were noted and added to the history section of the Canine New-Patient Form (appendix C).

APPENDIX H

THE ADJUSTING INSTRUMENT

APPENDIX LIST