CHAPTER II
LITERATURE REVIEW

Joint classification

Joint can be classified into 3 major types. Synarthroses are non – motile joint. An example of this type of joint would be found between the different bone of the skull. The second joint type is an amphiarthrosis, which is slightly mobile and can be found between vertebrae. The third type of joint, which is the most important for athletic function, is a diarthrosis or synovial joint. These are mobile joints, which are found in the limbs and are prone to develop arthritis (16).

Structure of Diarthrodial joint

The equine joint structure consists of the articulating surfaces of large bone covered by articular cartilage, the synovial membrane, the fibrous joint capsule, a cavity containing synovial fluid, and associated ligaments as shown in figure 1 and 2 (11). It has two major functions: 1) to enable movement and 2) to transfer load. The structure of the synovial joint is designed to facilitate these two major functions (10). The joint capsule is composed of two parts: the fibrous outer joint capsule, which is continuous with the periosteum or perichondrium, and the inner synovial membrane, which lines the synovial cavity (17). The synovial membrane secretes the synovial fluid, which provides lubrication within the joint itself (3). The membrane is a modified connective tissue with essentially highly vascularization and, therefore, manifested a typical inflammatory response (18). The capsule has sensory nerve ending and, in most cases, the pain associated with joint inflammation arises from the joint capsule. The nutrients required by the joint tissue are supplied by blood vessels which are in close association with synovial membrane (11). The joint stability is maintained by a fibrous joint capsule, which attaches to both bones and collateral ligaments, which are at the sides of most joints (figure 3). Collateral ligaments are in joints such as fetlock, carpus, elbow, hock and stifle. There are also intraarticular and extracapsular ligaments (outside the joint cavity) (3). Strong joint ligaments provide stability and protection for the joint and also

contribute to keep flexion and extension of the joint within certain limits. The joint cavity is filled completely by synovial fluid, which acts as a mean to provide nutrient substances to cartilage and lubricates the soft tissue within the joint to prevent inflammation and pain (19).

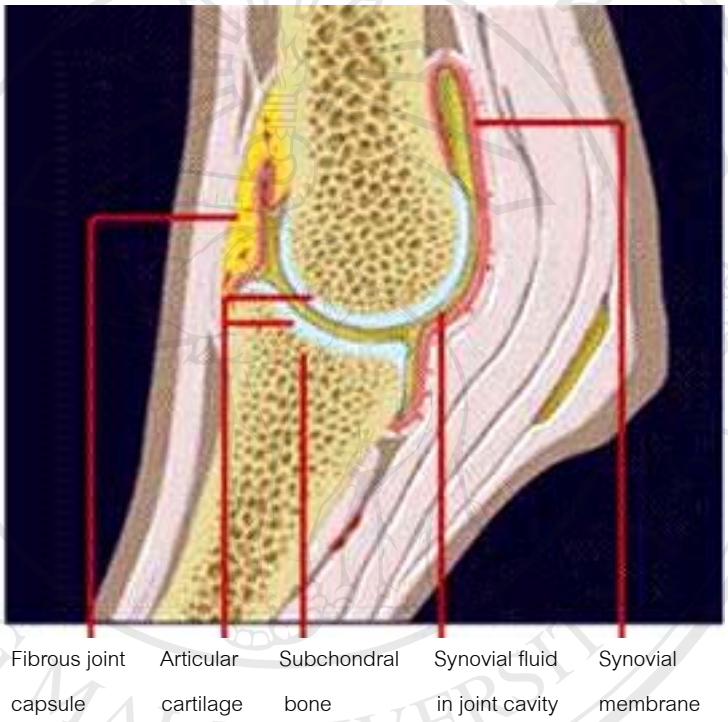

Figure 1 Structure of diarthrodial joint (11).

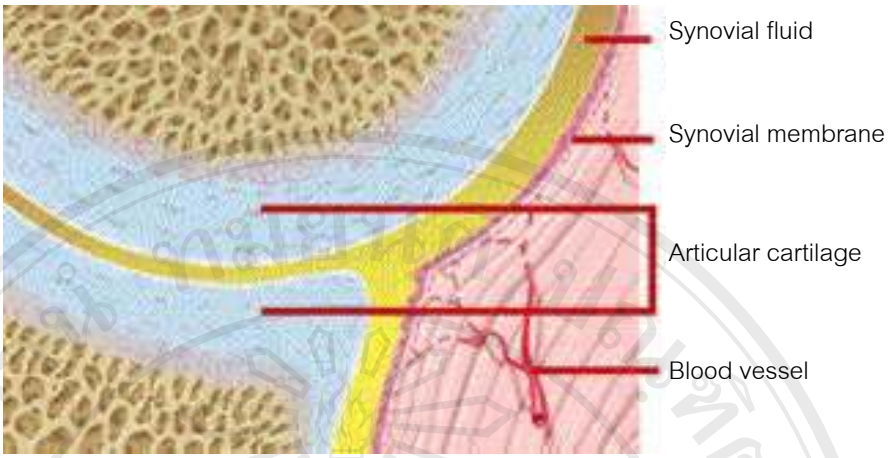

Figure 2 Structure of diarthrodial joint (close up) (11).

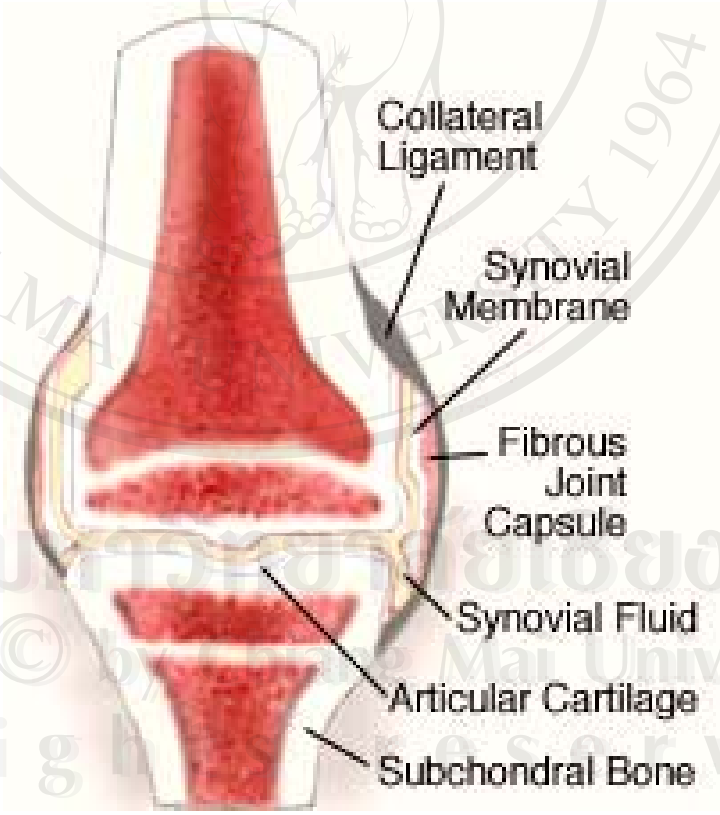

Figure 3 Structure of diarthrodial joint and collateral ligament (17).

Articular cartilage

The articular cartilage consists of hyaline cartilage, which appears as a glasslike structure containing cell. The glasslike material outside the cells is called extracellular matrix. The matrix is made up by a framework of collagen fibrils containing molecules called proteoglycans. Proteoglycan consists of the core protein with side chains of glycosaminoglycans (3). The translucent, glasslike appearance of articular cartilage is due primarily to its high water content (70% by weight in mature cartilage, and approaching 80% in neonatal cartilage) and the very fine structure of its collagen fibril network. On a dry weight basis, articular cartilage contains about 50% collagen, 35% proteoglycan, 10% glycoprotein, 3% mineral, and 1% lipid; it also contains 1-12% chondrocytes (by volume) (10).

Hyaline cartilage covering the articular surfaces of diarthrodial joints is a highly specialized connective tissue with a biomechanical function that is particularly suited to bearing compressive load (10). Cartilage is a tissue in which the cells (chondrocytes) comprise only a few percent of the volume, and the major part of the tissue is a highly organized and expanded extracellular matrix. The important biomechanical properties of this tissue come from two parts. First, the composition of a dense network of fine collagen fibrils is to form extracellular matrix and tensile properties of the tissue. Second, a high concentration of aggregated proteoglycan (predominantly aggrecan) binding to hyaluronan. Aggrecan draws water into extracellular matrix by osmosis and exerts a swelling pressure on the collagen network (20). The retention of aggrecan in complex form with hyaluronan within the inextensible collagen network causes the swelling pressure and makes the tissue ideal for resisting compressive load with minimal deformation, thereby supporting its function as a tough and resilient load bearing surface (figure 4) (21).

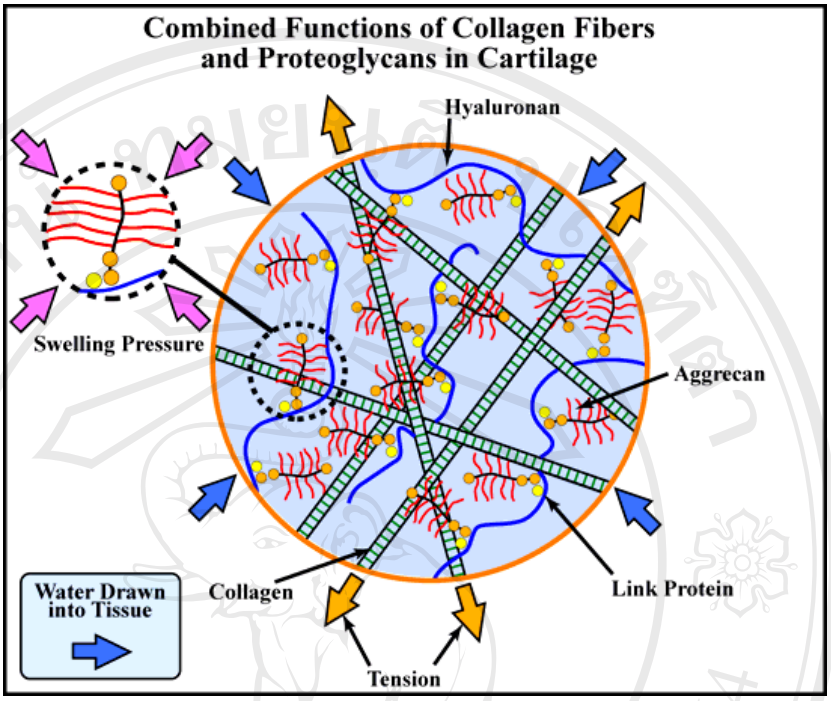

Figure 4 Organization and expansion of extracellular matrix of articular cartilage (21).

Collagen

Most of the collagen in articular cartilage is type II (85 to 90% of the total), and small amounts of types VI, IX, XI, XII and XIV are also present. Type II collagen is generally thought to provide the tensile strength of the articular cartilage. Equine type II collagen has a structure similar to that of other species and has a higher hydroxylation of lysine residues and more glycosylation than equine type I collagen (10).

Proteoglycan and Glycosaminoglycan

In addition to collagen, proteoglycan is the major solid components of articular cartilage. It has important role as a sponge that absorb the water into cartilage matrix and support the collagen network, this allow cartilage resist compressive load without damage (22). Proteoglycan consists of one or more glycosaminoglycan chains covalently attached to a protein core. The recent nomenclature is based on a relatively invariant element, the core protein, to which various glycosaminoglycans are attached. The glycosaminoglycan chains consist of two regions, a linkage region, by which they are attached to a protein core (except in the case of hyaluronan), and a repeating disaccharide. There are several glycosaminoglycan components of proteoglycan in cartilage as shown in table 1. Many researchers have tried to identified proteoglycan subpopulation either directly from cartilage and indirectly from body fluid by using immunolocalization or separating component of proteoglycan in order to study the cartilage proteoglycan metabolism (18, 23-24).

Table 1 Nomenclature for proteoglycans found in cartilage (10).

Glycosaminoglycan Name	Primary Core Protein	Wet Weight of Cartilage (%)*	Wet Weight (nmol/gm)*	Other Names	Repeating Unit in Glycosaminoglycan (GAG)
Chondroitin sulfate	Aggrecan	5–10	1–10	PG-LA1	*N*-acetylgalactosamine-β(1–4)-glucuronic acid–β(1–3)
Dermatan sulfate	Decorin	0.03–0.12	0.3–0.6	PG-S2 PGII	*N*-acetylgalactosamine-β(1–4)-glucuronic acid–β(1–3)
	Biglycan	0.06–0.24	0.25–0.5	PG-S1 PGI	*N*-acetylgalactosamine-α(1–4)-iduronic acid–α(1–3)
Heparan sulfate	n.a.				*N*-acetylgalactosamine-β(1–4)-glucuronic acid–β(1–3) *N*-acetylgalactosamine-α(1–4)-iduronic acid–α(1–3)
Keratan sulfate	Aggrecan			PG-LA1	*N*-acetylglucosamine-β(1–3)-galactose–β(1–4)
	Fibromodulin	0.1–0.3	1.5–5	59-kDa protein	*N*-acetylglucosamine-β(1–3)-galactose–β(1–4)
Hyaluronan	None	0.05–0.25	0.03–0.8	Hyaluronic acid	*N*-acetylglucosamine-β(1–4)-glucuronic acid–β(1–3)

*Figures for nmol/g are approximate; these molecules are particularly heterogeneous, and estimates of their molecular mass vary by as much as 50%. In addition, calculations of the percentage wet weight of cartilage are prone to error based on the efficiency of extraction. To further complicate matters, the amounts of most components vary with age and exact tissue source. These figures are thus only a rough guide.

n.a. = not applicable

From Neame P: Extracellular matrix of cartilage: Proteoglycans. *In* Woessner JF, Howell DS (eds): Joint Cartilage Degradation: Basic and Clinical Aspects. New York, Marcel Dekker, Inc, 1993, p 113, by courtesy of Marcel Dekker, Inc.

Aggrecan

The large aggregating proteoglycan, which is found the most abundant in cartilage, is called “Aggrecan” (20). The aggrecan structure consists of an expanded core protein, which are attached by many chondroitin sulfate and keratan sulfate chains. This form are densely substituted branched or “bottle brush” structure as shown in figure 5 (25). Aggrecan, whose molecular mass is about 2500 kDa, could be found relatively restricted to several tissues including cartilage, brain, aorta and tendon. The core protein binds with hyaluronan by link protein and forms supramolecular complex (26).

The core protein has high molecular weight (approximately 250 kDa) encoded by a single gene that is expressed predominantly in cartilaginous tissue (20). It has 3 globular and 2 extended domains (figure 5). And as described above, it consists of mainly 2 types of glycosaminoglycan chains, the major chondroitin sulfate and minor keratan sulfate, they are normally 20 kDa each in approximate. The chondroitin sulfate chain, either 4-sulfated, 6-sulfated, or usually both, are all attached to the long, extended domain between globular domain 2 and 3, while the keratan sulfate chains are more widely distributed. They are most abundant in a keratan sulfate-rich region just C-terminal to the G2 domain (21).

The globular N-terminal G1 domain, of aggrecan contains an immunoglobulin-like binding site (27-28), which has a high affinity for hyaluronan and is responsible for the formation of aggregates. Because of a long, unbranched chain with several millions molecular weight of hyaluronan, in each chain can bind a large number of aggrecans, resulting in aggregates forming of up to several hundred millions in molecular weight (21).

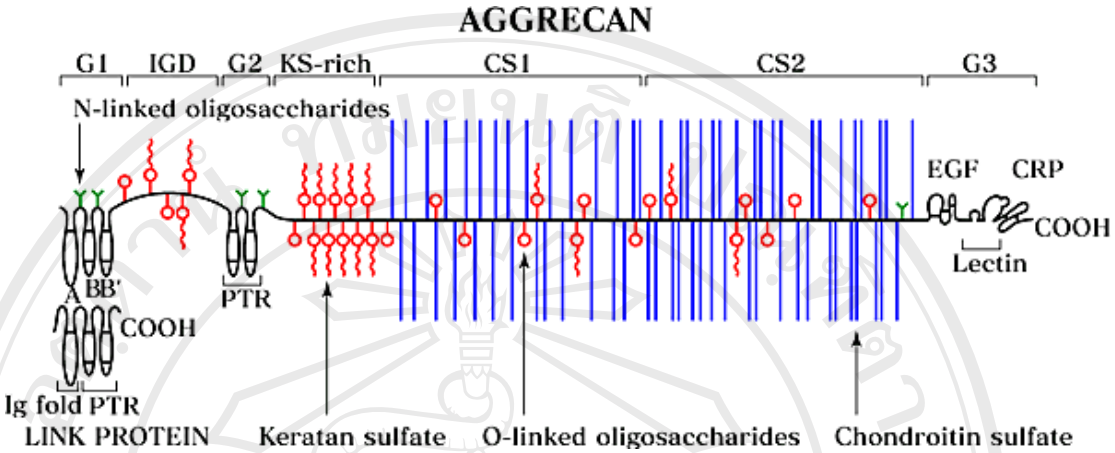

Figure 5 Cartilage proteoglycan (aggrecan) structure (21): G1 = globular domain 1, G2 = globular domain 2, G3 = globular domain 3, IGD = interglobular domain, CS1 = chondroitin sulfate region 1, CS2 = chondroitin sulfate region 2, EGF = epidermal growth factor-like domain, CRP = complement regulatory protein - like domain, PTR = proteoglycan tandem repeat

Chondroitin sulfate

Chondroitin sulfate is a major glycosaminoglycan, which is formed of repeating disaccharide subunits of glucuronic acid (glcUA) and N-acetylgalactosamine (galNAC) (16, 23). Sulfation of glycosaminoglycans in chondroitin sulfate chains is usually regular, one sulfate per disaccharide throughout the chain (22). The galNAC portion may be unsulfated or sulfated at the 4 or 6 position (Δ diC-6-s or Δ diC-4-s) (29).

Monoclonal antibodies against proteoglycan fragments

Over the past decade, researchers have attempted to specifically identify and quantitate types and amounts of articular cartilage components that are liberated into synovial fluid and ultimately into the serum as articular cartilage degeneration occurs (15). Several assays have been developed to recognize proteoglycan fragment from aggrecan (30) in order to study the catabolism or anabolism of cartilage.

Monoclonal and polyclonal antibodies targeted to bind epitopes from articular cartilage have given researchers a more specific and sensitive tool for studying articular cartilage metabolism and pathology (15). When cartilage degrade, specific epitopes located on cartilage proteoglycan and collagen fragment present in synovial fluid and serum. Once a monoclonal or polyclonal antibody binds to a specific epitope, a specific area between antigen and antibody has been produced. Therefore, the amount of epitope can be measured using a radioimmunoassay or ELISA (15). One approach to monitor articular cartilage destruction is to use ELISA to detect glycosaminoglycan epitopes in synovial fluid or blood (31-37). Keratan sulfate and chondroitin sulfate have been most frequently chosen in case of proteoglycan fragment determination.

Focused on chondroitin sulfate epitope, monoclonal antibody 846, specific to chondroitin sulfate epitope (846) has been described. The epitope 846 is indicated by a recent study (8). It is found as the only the largest, fully aggregatable aggrecan molecules presenting on newly synthesized molecules. Serum and synovial fluid concentrations of epitope 846 were found to be associated with osteochondrosis.

Increase in concentration of epitope 846 suggests the increase in synthesis of cartilage aggrecan (8).

Monoclonal antibody WF6 was developed to recognize the WF6 epitope in a native chondroitin-6-sulfate in human serum using competitive ELISA and aggrecan (A1D1 fraction) (38). Preparation of the WF6 monoclonal antibody has been described in a previous study (39). It was found that the WF6 was higher in the serum of osteoarthritic patient than in the normal serum. The other study also found the significant higher level of WF6 in the serum of patient with rheumatic arthritis than in normal serum (38). Therefore, WF6 epitope might be able to reflect the degradation of cartilage without being digested with chondroitinase.

Monoclonal antibodies against keratan sulfate have been studied and described. The researchers found that age, sex and breed did not have significant effects on plasma keratan sulfate concentration in horses with osteochondral chip fracture, other closed intraarticular fracture, inflammatory arthritis (synovitis), infectious arthritis, or osteochondrosis (14). There was also found these horses showed significant higher plasma keratan sulfate concentration than clinically normal horses, but horses with osteoarthritic did not. It is possible that horses with OA were already in an advanced stage of disease with minimal articular surface left to be degraded (14). Other research found that keratan sulfate and ratio of keratan sulfate: total glycosaminoglycans (KS:GAG) in synovial fluid concentration in clinically osteoarthritic joints were slightly lower than the contralateral joints (40). However, It was found that serum keratan sulfate on osteoarthritis was significantly higher than that in normal horses, while no significant difference was found in keratan sulfate levels of synovial fluid between normal and osteoarthritic horses (41).

Principle of Competitive Inhibition ELISA

Enzyme-link immunosorbent assay, sometimes called ELISA, is one of the immunoassay. It combines the specificity of antibodies with the sensitivity of simple

spectrophotometric enzyme assay by using antibodies of antigen coupled to an easily assayed enzyme.

In the competitive inhibition method, plates are coated by known coating antigens. Unknown or known amounts of antigen are allowed to react with a primary antibody. The excess antibody will be coupled with coating antigen. Then the secondary enzyme-labeled antibody is added in order to react with the remainder primary antibody. After the complex is washed in buffer, the substrate is added, and enzyme activity is measured.

The value of chondroitin sulfate epitope (WF6 epitope) in serum is measured by competitive inhibition ELISA using a method similar to that described in recent study (42). In competitive inhibition ELISA for WF6, shark proteoglycan (A1-fraction) is used as coating antigen, shark proteoglycan (A1D1-fraction) as competitor, WF6 monoclonal antibody (mAb WF6) as primary antibody and the IgM-specific peroxidase conjugated anti-mouse immunoglobulin as secondary antibody.

The sample will be analyzed by using ELISA and standard will be used for standardization of WF6 concentration. Intra-assay was determined by using 20 replicated analyses in control horse serum. Inter-assay was determined by using triplicate measurement of different plates.

In previous study, ELISA was developed to detect the WF6 epitopes on human serum using aggrecan (A1D1-fraction). WF6 epitope was found to be higher in the serum of osteoarthritic patient than in normal serum, and it was also significantly higher in the serum of patient with rheumatic arthritis than in normal serum (38). In one study, there was no different significance of WF6 concentration in any age groups of normal horses (42). There was also found the osteoarthritic horses have had the higher WF6 epitope than in non-osteoarthritic horses. This indicated that WF6 could reflect the catabolism of cartilage. Thus, WF6 epitope is a sensitive marker in response to the destruction of articular cartilage. Therefore, it is likely that this chondroitin sulfate epitope could be able to be the one of effective marker for degenerative joint diseases (42).

Examination of limb lameness (43)

Lameness is an indication of a structural or functional disorder in one or more limbs that is evident while the horse is standing or in movement. The examiner must also be able to differentiate between lameness resulting from painful and nonpainful alterations in gait, often referred to as mechanical lameness and lameness resulting from neurologic dysfunction. To make this differentiation, a complete history is taken. The horse is then observed at rest and at exercise to identify the limb or limbs involved. Next, the examiner palpates and performs manipulation to identify the region of pain. Diagnostic anesthesia and imaging may follow to clarify the location of pain or problem.

1. Signalment and use

Patient age and use are important considerations. For example, trail riding will have a higher incidence of problems associated with the forefeet, low-motion joints (e.g., pasterns and distal tarsal joints), and ligaments. In contrast, a racehorse most often presents with lameness associated with high-motion joints (e.g., carpus and fetlock), sprain or strain of flexor support structures, and stress-related fractures.

2. History (Anamnesis)

A detailed medical history should be obtained on every horse. Records should include specific information regarding the duration and intensity of the lameness, the symptoms, the activity immediately preceding the lameness, and any previous, treatments or therapies employed.

3. Visual examination

At Rest, a careful visual examination is made with the horse standing squarely on the flat surface at rest. This should be done at a distance and then up close, with the horse viewed from all directions. From a distance, the body type is characterized (stocky vs. slender), conformation is noted, and body condition and alterations in posture, weight shifting, and pointing are also noted.

At close observation, each limb and muscle group is observed and compared to its opposing member for symmetry and swelling.

At exercise, the characteristics of the gait of all limbs should be observed from a distance. The main objective in exercising the horse is to identify the limb or limbs involved and the degree of lameness and incoordination in movement. To do this, the horse is observed at a walk and trot in a straight line and then while lunging in circles. Sometimes, it is helpful to observe the horse under tack or high speed on the treadmill. Examination includes watching the horse from the front, side, and rear. In general, forelimb lamenesses are best viewed from the front and side, and hindlimb lamenesses are best observed from side and rear. What the examiner is looking for is head nodding, gait asymmetry, alterations in height of the foot flight are, alterations in flight, phase of stride, joint flexion angle, foot placement, degree of fetlock extension with weight bearing.

4. Palpation and manipulation

After observing the animal at exercise, make a close visual examination, including palpation of the limbs. In either case, a systematic method of palpation should be followed so nothing is overlooked. The palpation is done for identify the region or point of pain. Joint palpation and manipulation are assessed for swelling (edema, firm), pain, range of motion and heat. Fetlock joint, the dorsal aspect and palmar / plantar reflection of the metacarpophalangeal joint are palpated for thickening and swelling, which mat indicate an idiopathic synovitis, chronic proliferative synovitis / capsulitis, chip fracture of the proximal phalanx, or articular fracture. A flexion test is performed by holding and flexing the fetlock for 30 seconds, after which the horse is trotted off and observed for lameness. The carpus, point swelling associated with the antebrachiocarpal and middle carpal joints that occurs medial to the extensor carpi radialis tendon usually indicates chip fracture. More diffuse swelling of these joints may indicate synovitis / capsulitis, articular slab fracture, DJD. Palpation of the carpal joints and bones, including the accessory carpal bone, is the best done with the carpus flexed. The degree of carpal flexion can be evaluated first. The carpus is flexed for 30 seconds, after which the horse is jogged and observed for increased lameness.

5. Special Considerations

Hyperthermia (heat) is the best checked by touching the area with the back of hand and comparing this with the opposite limb. Crepitation should be checked, the crepitus sound without pain may be produced in normal horse.

6. Local anesthesia

Local anesthesia is commonly used to confirm or identify the site or sites of pain when obvious pathology does not exist. It also useful to prove a diagnosis to the horse's owner who is suspicious of another site of pain causing the lameness.

7. Arthroscopy

The arthroscope was used purely as a diagnostic tool from about 1975 to 1980. Technique for doing surgery under arthroscopic visualization started to be developed in 1979 and now virtually all joint surgery is done arthroscopically. In addition, specific diseases are confirmed with diagnostic arthroscopy, including tearing of the medial palmar intercarpal ligament, cruciate ligament tearing and various degree of OA. Arthroscopic surgical removal of the carpal chip fractures is the treatment of choice for the most cases, particularly if return to racing performance is desired.

Equine arthritis

Arthritis may be defined simply as inflammation of a joint. It is a nonspecific term (7). There are various disease processes that affect the nature of synovial fluid because of inflammation and disease in the synovial membrane. The most common sign that the horse owner or trainer sees of any kind of arthritis is excessive fluid production (joint swelling) (3). When considering a traumatically injured joint, two basic pathobiologic processes should be considered: 1) inflammation of the synovial membrane and fibrous joint capsule (synovitis and capsulitis) and 2) physical or biochemical damage to the articular cartilage and bone. Acute synovitis and capsulitis can cause significant clinical compromise and have the release of enzymes, inflammatory mediators, and cytokines which may also contribute to the degenerative process in the joint (7).

Equine intraarticular chip fracture

Osteochondral fragmentation, or chip fracture, is a common affliction of racehorses (8). It is particularly important because it can potentially lead to osteoarthritis. If it is not treated in an appropriate and timely fashion, osteoarthritis is inevitable (44).

The presence of fragment within equine joints comes from two main etiologies: traumatic injury and osteochondritis dissecans. The most common places of traumatically induced osteochondral chip fragmentation are in the carpal and fetlock joints (45).

Although chip fractures are frequently considered as acute injuries and recognized with acute clinical signs, it has been suggested that they are the subsequent complication following the alteration of joint margins due to OA. It has been proposed that chip fractures of the joint margins in the carpus arise from at least two different pathogenetic condition: 1) fragmentation of the original tissue of the joint margin (this lesion starts as progressive subchondral bone sclerosis induced by the repetitive trauma of training and racing with eventual damage of articular cartilage because of the noncompliant subchondral bone; eventually the sclerotic bone undergoes ischemic necrosis and subsequent fragmentation), or 2) within the base of periarticular osteophytes forming in OA.

Fragmentation of the osteochondral articular surfaces has direct physical effects because of the loss of a smooth congruent articular surface, as well as the release of cartilage and bone debris, which may lead to synovitis. Sufficiently severe compromise of the articular surface leads to instability, as does tearing of fibrous joint capsule and ligaments. Synovial membrane in turn has the potential to respond directly to mechanical trauma and indirectly to injury elsewhere in the joint. Direct trauma to synovial membrane also increases vascular permeability. Direct damage to the synoviocytes within the synovial membrane liberates lysosomal enzymes, cytokines, and possibly other mediators that can lead to articular cartilage degeneration. Damage to articular cartilage also releases wear particles and, possibly, other soluble breakdown

products. These materials in turn can activate the synovial membrane to increase production of proteinase, prostaglandins, cytokines, and other biochemical mediators. The inflammation arises from the injury leads to collagen deposition and cross-link, not only within individual injured tissues but also between periarticular tissues. Stiffness and contracture result and persist long after the inflammation has fully subsided (45).

The treatment of choice when the osteochondral fragmentation occurs, is removing the fragment by arthroscopic surgery for the immediately relief of clinical signs, as well as to prevent further development of OA.

Equine osteoarthritis

OA may be considered as a group of disorders characterized by a common end stage: progressive deterioration of the articular cartilage accompanied by changes in the bone and soft tissues of the joint. The deterioration of the articular cartilage is characterized by local splitting and fragmentation (fibrillation) of articular cartilage. Synovitis and joint effusion are often associated with the disease. OA may be preexisting and may predispose to fracture, or it may occur secondary to chronic fracture (46). OA can be divided into 4 entities and fifth condition of uncertain status as shown in table 2.

The first type typically affects athletes. It is commonly associated with racing and affects the highly mobile joints such as the carpal and metacarpophalangeal joint. The fourth type includes cases that develop secondarily to some other primary joint problems such as intraarticular fractures, unresolved osteochondrosis and infectious arthritis.

Table 2 Degenerative joint disease entities in the horse (adapted from (47)).

Type	Characteristics
1	Acute – associated with synovitis and high – motion joints
2	Insidious - associated with low – motion joints
3	Incidental or "nonprogressive" articular cartilage erosion
4	Secondary to other identified problems (a) Intraarticular fractures (b) Dislocation / ligamentous rupture (c) Wounds (d) Septic arthritis (e) Osteochondrosis
5	Chondromalacia

Clinically, the disease is characterized by pain and dysfunction of the affected joint (47). The signs of OA are clinically progressive dysfunction of the joint. There are swelling, lameness and progressive stiffness develops in the soft tissue. In advanced stages, loss of joint space on the radiographs and formation of bone spurs (osteophytes) could be seen as well as mineralization within the joint capsule (enthesophytes) (48).

Under normal condition of articular cartilage, proteoglycans are turned over at a constant rate and equilibrium exists between synthesis and degradation. In contrast, the normal balance of both metabolisms will be lost if joint disease occurs.

Repeated trauma or stress to the joint from everyday use, athletic training, or performance, is often the initiating cause of joint inflammation. Lameness, swelling and heat are usually the results of inflammation in the synovial membrane and joint capsule. The initial inflammation usually involves only the soft tissue structures of the joint (synovial membrane/joint capsule), while cartilage damage is generally not present at the early stage. In joint inflammation, the synovial membrane become inflame due to injury, a condition referred to as synovitis. This allows leukocytes, or white blood cells, which are normally filtered out of the joint, to invade the joint space. The inflamed synovial membrane and the leukocytes release destructive enzymes such as free radicals, cytokines, and prostaglandins which are potentially damaging to the articular cartilage (figure 6) (49). Left untreated, or allowed to recur repeatedly these inflammatory mediators produced by the inflamed joint, this can leads to the final stage of osteoarthritis by cycle of joint destruction as shown in figure 7 (50). Beside cyclic and athletic trauma, many etiopathogenetic factors are also involved the morphologic breakdown of articular cartilage in osteoarthritis (51) as shown in figure 8.

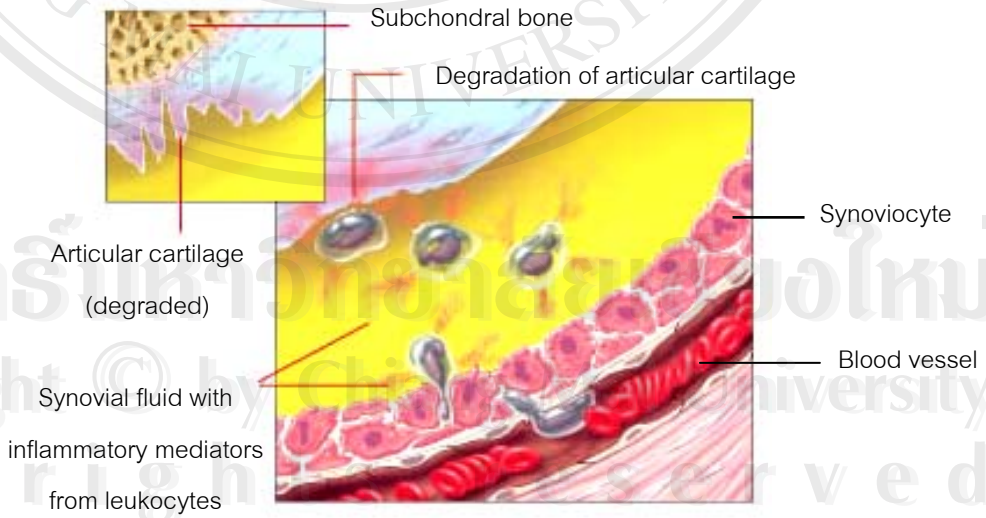

Figure 6 Cartilage degradation (49).

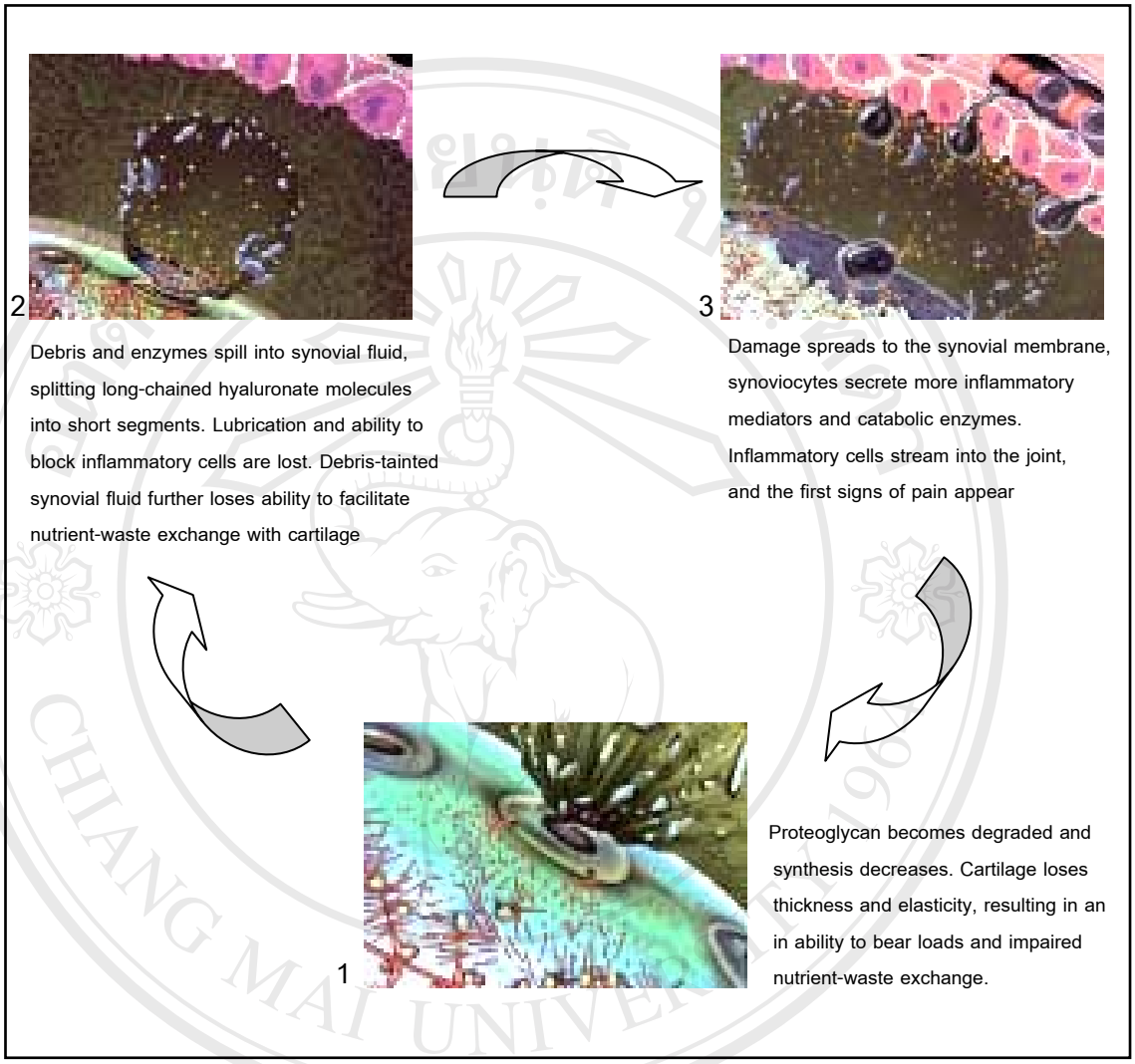

Figure 7 Catabolic cycle of articular cartilage in joint disease (adapted from (50)).

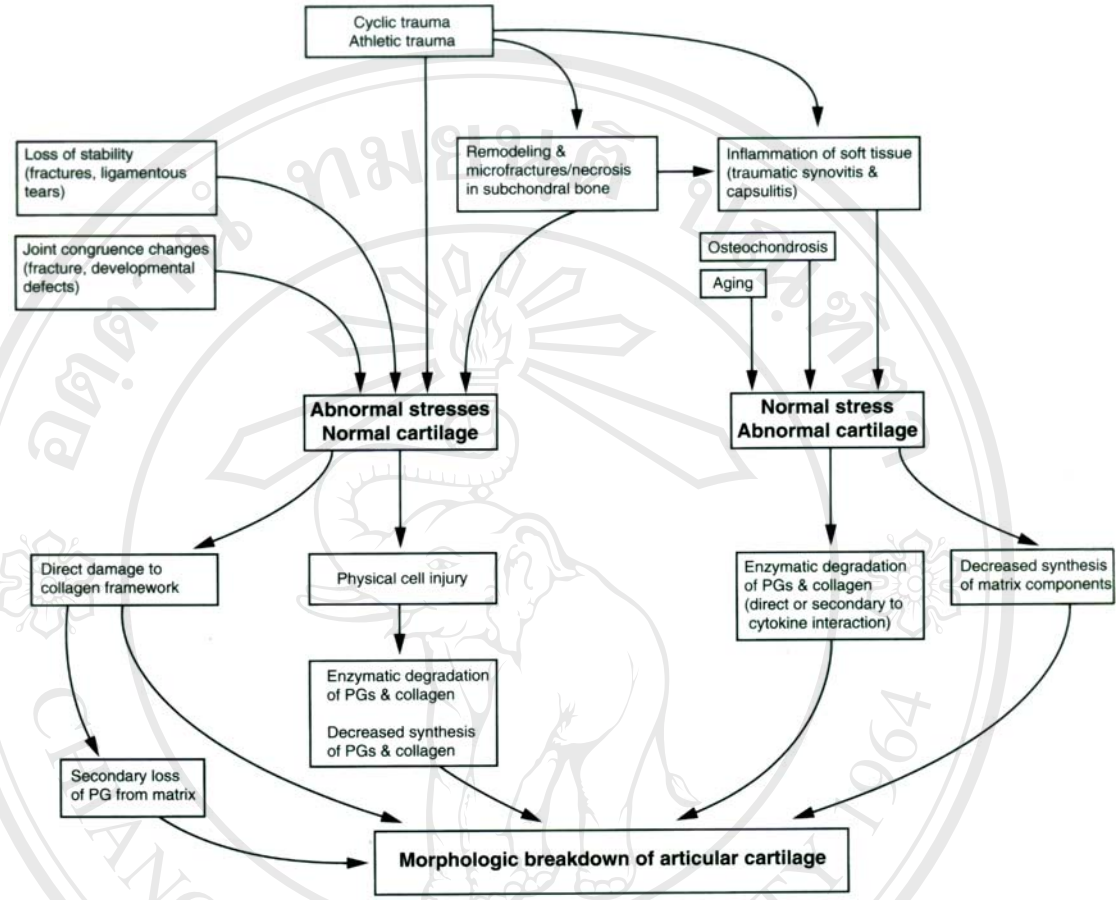

Figure 8 Factors involved in articular cartilage degradation in equine osteoarthritis (51).

There are many diagnostic tests and also treatment of osteoarthritis (13, 18). It has been known that radiography is the most convenient noninvasive imaging technique being used to evaluate osteoarthritis in horse. Unfortunately, by the time of radiographic changes of osteoarthritis are recognized, the structural alterations in the articular cartilage are already irreversible (14). Thus the methods of assessing the extent of articular cartilage destruction in vivo before radiographic changes are evident in affected joints may help clinician select appropriate treatment to prevent development of OA (14). In recent years, many biochemical markers were used to detect breakdown products such as keratin sulfate, chondroitin sulfate, in serum and synovial fluid, and were developed as a specific tool for the early detection and monitoring of OA.

OBJECTIVES

1. To compare the level of chondroitin sulfate epitope (WF6 epitope) in serum between normal horses and horses with arthritis, osteochondral (chip) fracture or osteoarthritis.
2. To compare the level of chondroitin sulfate epitope (WF6 epitope) in serum of horse with osteochondral fracture between before and after treatment by arthroscopic surgery.
3. To compare the level of chondroitin sulfate epitope (WF6 epitope) in synovial fluid between abnormal and contralateral normal joints in horses with osteochondral fracture or osteoarthritis.