ACTA UNIVERSITATIS AGRICULTURAE SUECIAE

VETERINARIA 74

Bone Spavin

Clinical and epidemilogical aspects of degenerative joint disease in the distal tarsus in Icelandic Horses

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Akademisk avhandling som för vinnande av veterinärmedicine doktorsexamen kommer att offentligen försvaras i Ettans föreläsningssal, Klinikcentrum, SLU, Uppsala, fredagen den 7 april, kl.13.00.

Abstract

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Cross-sectional investigations were performed to assess the prevalence of, relationship between, and risk factors for, *radiographic signs of DJD in the distal tarsus* (*RS*) and of *hind limb lameness* (*lameness*). Clinical cases were studied to assess the possible benefit of surgical treatment vs. conservative treatment for lameness due to DJD in the distal tarsus.

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RS were found in 23% and 30.3%, respectively, of the horses in the two populations investigated. The prevalence of *lameness* after flexion test was 25% in the Swedish population and 32.4% in the Icelandic population. No horses were found with *RS* or *lameness* in the age-span 0-4 years. The prevalence of *RS* and *lameness* were similar in the 6-12 year age group in the two populations investigated. Horses with *RS* had a fourfold risk of being lame when compared against horses without them ($P<0.001$).

Age and tarsal conformation were identified as risk factors for *RS*. Sire, age when broken to saddle, participation in stud shows, and gait were identified as risk factors for *lameness*.

Of the lame horses treated by surgery, 65% (n=13) improved and in the conservatively treated group, 56% (n=9) improved. The difference in recovery rates between the two treated groups was not statistically significant.

Key words: bone spavin, lameness, osteoarthritis, tarsus, horse, Icelandic Horse, prevalence, risk factors, treatment.

Distribution:

Swedish University og Agricultural Sciences
Department of Large Animal Clinical Sciences
S-750 07 Uppsala, Sweden

Uppsala 2000
ISSN 1401-6257
ISBN 91-576-5918-4

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Acta Universitatis Agriculturae Sueciae
Veterinaria 74

ISSN 1401-6257
ISBN 91-576-5918-4

Tryck: SLU Service/Repro, Uppsala 2000

”Spatt voro de meste hästar här plågade av, så att bakbenen hade ofta knylor stora som gåsägg, så på yttre, som på inre sidan, vilket fömentes kommit av en hingst från Hällekis, som haft den samma sjukdom, varav hela dess avkomma fått denna arvsjuka. Härav ses, huru väl det vore, om hingstar eller sto alldeles förbödes, på det hela landet ej må blifva uppfyllt med odugeligt hästelag.”

Carl von Linné, Västgötaresan 1746.

Abstract

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Benspatt - degenerativ ledsjukdom i distala tarsus - hos Islandshästen

Degenerativ ledsjukdom i hasens glidleder kallas allmänt för benspatt. Detta är ett sedan urminnes tider känt benlidande hos häst. Av svensk försäkringsstatistik framgår att benspatt är en av de vanligaste orsakerna till bakbenshälta hos både arbetshästar och ridhästar i Sverige. I samband med att Islandshästpopulationen ökade kraftigt i Sverige under 1980 och 1990-talet noterades också att benspatt var en relativt vanlig diagnos vid hältutredningar och besiktningar av islandshästar, vilket också avspeglat sig i försäkringsstatistiken.

I detta arbete har utbredning och klinisk manifestation av benspatt hos Islandshäst undersökts. Potentiella riskfaktorer för benspatt och därtill associerad bakbenshälta har undersökts, vidare har värdet av kirurgisk och icke-kirurgisk behandling för bakbenshälta orsakad av benspatt utvärderats.

Totalt har 1029 islandshästar, 668 valacker, 321 ston och 40 hingstar undersökts för dessa studier. Fakta har erhållits genom kliniska och radiologiska undersökningar samt genom intervjuer med hästarnas ägare eller tränare. För undersökning av utbredning (prevalens), klinisk betydelse och riskfaktorer i den svenska Islandshästpopulationen valdes elva gårdar ut. Samtliga islandshästar på dessa gårdar undersöktes, totalt 379 stycken i åldrarna 1-19 år. För prevalensstudier och för utökad analys av riskfaktorer undersöktes hästar i åldrarna 6-12 år på Island. Majoriteten av dessa (n=420) var efter 17 stycken av oss utvalda avelshingstar, som tillsammans representerade alla avelslinjer av betydelse på Island. Ytterligare 194 hästar i samma åldersgrupp ingick i studien. På SLU:s stordjursklinik valdes 36 islandshästar, som var halta på grund av benspatt, ut för utvärdering av kirurgisk och icke-kirurgisk behandling.

Benspatt och därtill associerad bakbenshälta visade sig vara vanligt förekommande i Islandshästpopulationen. Radiologiskt påvisades benspatt hos 23% respektive 30% av de undersökta hästarna i Sverige och på Island. Motsvarande siffror för bakbenshälta var 25 respektive 32 procent. Sambandet mellan radiologiskt påvisad benspatt och bakbenshälta var mycket starkt. Hästar med röntgenfynd hade fyra gånger högre odds att visa tecken på hälta än hästar utan röntgenfynd. Med hjälp av palpation och rörelsekontroll med böjprov kunde 75% av hästarna med radiologiska tecken på benspatt identifieras.

Ålder och hasexteriör identifierades som riskfaktorer för radiologiskt påvisad benspatt och fadershingst, inridningsålder, deltagande i avelsbedömning och gångarter identifierades som riskfaktorer för bakbenshälta. Förutom en negativ effekt av sen inridningsålder (6 år eller äldre) och att inte ha deltagit i avelsvärdering kunde inga negativa effekter av tillämpade inridningsrutiner, träningsrutiner eller användningsområden identifieras.

I behandlingsstudien förbättrades 65% (n=13) av kirurgiskt behandlade hästar jämfört med 56% (n=9) i den icke-kirurgiskt behandlade gruppen. Skillnaden mellan de behandlade grupperna kan avspegla en sant bättre effekt av kirurgisk behandling men kan också bero på snedselektering vid rekryteringen av fall eller på grund av undermedveten överskattning av behandlingsresultatet efter kirurgisk behandling.

Content

Appendix

The thesis is based on the following papers which will be referred to in the text by their Roman numerals:

I. Eksell P, Axelsson M, Broström H, Ronéus B, Häggström J, Carlsten J. Prevalence and Risk Factors of Bone Spavin in Icelandic Horses in Sweden: A Radiographic Field Study. Acta vet. scand. 1998; 39: 339-348.
II. Axelsson M, Eksell P, Ronéus B, Broström H, Häggström J, Carlsten J. Relationship between Hind Limb Lameness and Radiographic Signs of Bone Spavin in Icelandic Horses in Sweden. Acta vet. scand. 1998; 39: 349-357.
III. Björnsdóttir S, Axelsson M, Eksell P, Sigurdsson H, Carlsten J. A Radiographic and Clinical Survey of Degenerative Joint Disease in the Distal Tarsal Joints in Icelandic Horses. Accepted for publication in Equine Veterinary Journal.
IV. Axelsson M, Björnsdottir S, Eksell P, Häggström J, Sigurdsson H, Carlsten J. Risk factors associated with hind limb lameness and degenerative joint disease in the distal tarsus in Icelandic Horses. Accepted for publication in Equine Veterinary Journal.
V. Axelsson M, Eksell P, Ronéus B, Carlsten J. Surgical vs. conservative treatment of degenerative joint disease in the distal tarsus in the Icelandic Horse. Submitted.

The articles are published by the kind permission of the journals concerned.

Abbreviations

The following abbreviations are used in the text:

CD	centrodistal joint
DJD	degenerative joint disease
lameness	hind limb lameness at presentation and/or after flexion test
lig.	ligamentum
Mt III	os metatarsale III
OA	osteoarthritis
OR	Odds-Ratio
PIT	proximal intertarsal joint
RSBS	radiographic signs of bone spavin
RS	radiographic signs of degenerative joint disease in the distal tarsus
Tc	os tarsi centrale
T1-4	os tarsale I-IV
TMT	tarsometatarsal joint

Introduction

Concepts of degenerative joint disease in the distal tarsus

Degenerative joint disease (DJD) in the distal tarsus is historically referred to as spavin or bone spavin. In this thesis, and the articles on which it is based, the terms *osteoarthritis in the distal tarsus, degenerative joint disease in the distal tarsus* and *bone spavin* are used synonymously. Likewise, the expressions *radiographic signs of bone spavin* (RSBS) and *radiographic signs of DJD in the distal tarsus* (RS) are also used synonymously in this thesis. DJD may be defined as a group of disorders characterised by deterioration of the articular cartilage, accompanied by changes in the bone and soft tissues of the joint (McIlwraith and Vachon 1988). DJD in the distal tarsus refers to DJD occurring in the centrodistal (CD), tarsometatarsal (TMT) and proximal intertarsal joints (PIT). Degenerative joint disease in the distal tarsus of equines has been recognised in textbooks and scientific articles for several centuries or more (Thomas 1912; Taylor 1977).

Clinical background

In the late 80's and early 90's, there was a marked increase in the caseload of Icelandic Horses at the Large Animal Clinic of the Swedish University of Agriculture Sciences. It was also noticed that DJD in the distal tarsus was frequently diagnosed in these subjects. This was especially true in cases of lameness as well as in horses presented for pre-sale/purchase examinations. In some cases, radiographic signs of DJD in the distal tarsus were also detected in otherwise sound horses. In a follow-up study (Berntzen 1991) 21 Icelandic Horses with diagnosed bone spavin were studied. Eleven of these horses were euthanised due to the disease, seven were used for light riding or breeding, and only one case was reported to be in normal working condition. In Iceland, Einarsson (1931) reported bone spavin to be a common cause of lameness in the Icelandic Horse. This was supported by Stanek (1981), who reported the occurrence of DJD in the distal tarsus to be higher in Icelandic Horses than in other breeds. In a study of 60 Icelandic Horses with clinical suspicion of the disease, a radiographic examination revealed severe DJD in the distal tarsus in 58 cases (Sigurdsson 1991).

The Icelandic Horse

The Icelandic Horse has constituted an isolated population since the settlement of the country in the 9th and 10th centuries, being the only horse breed in Iceland (Adalsteinsson 1981). Icelandic horses have traditionally been used for riding and possess the ability to perform four or five different gaits, of which toelt and pace are the most characteristic. They are usually broken to saddle at the age of 4-5 years and are expected to be in full use by the age of 6. The most active period for riding is between 6 and 12 years, although they are often used up to the age of 20.

The development and state of breeding of Icelandic Horses have been well described by Hugason (1994). A short summary of her work will follow in order to give a very brief introduction to a well-developed system of modern horse breeding. The *Agricultural Society of Iceland* is officially responsible for the horse breeding policy and the official advisory cervices in Iceland. The first legislation on breeding was approved in 1891, since when many changes and additions have been made. A new *Livestock Act* was approved in 1989 and related regulations followed in 1991. In 1923, the *Register for Breeding Horses of the Agricultural Society of Iceland* began to register horses that met a certain standard at exhibitions. In recent years, registration has been extended and today the *Fengur* database is one of the fundamentals in the horse breeding system, the judging of horses being another. Conformation and riding qualities are estimated and recorded on a graded scale. The points for each trait are then multiplied by a factor according to importance in such a way that riding qualities have the greatest influence on the final score. The complete rules are published in Icelandic, English and German in *Kynbótadómar og syningar* by the Agricultural Society of Iceland. Data are evaluated with the aid of the Best Linear Unbiased Prediction (BLUP) and breeding indexes are published in the Agricultural Society's Annual Report on Horse Breeding (Hugason 1994). In 1996, the horse population in Iceland comprised approximately 80,000 horses, of which about 30,000 were in use as riding horses. The number of Icelandic Horses outside Iceland exceeds 100,000[1].

Anatomy and physiology

Bones

The tarsus consists of six bones that together with the distal tibia and the proximal metatarsal bones form the bone structure of the hock (Fig. 1). The dorso-proximal surface of the talus articulates towards the distal tibia, the distal surface articulates towards the calcaneus and the distal surface articulates with the os tarsi centrale (TC) and os tarsale IV (T4). The calcaneus is an elongated bone and forms a lever for the extension of the hock. Its most proximal part, the tuber calcanei, constitutes the insertion of numerous powerful muscles. Along the plantar aspect are attached the plantar ligament and, laterally and medially, the collateral ligaments. Besides the calcaneus articulations with talus, the calcaneus articulates with T4 at the distal aspect. TC is located distal to the talus and articulates with the fused os tarsale I-II (T1-2) at the medio-plantar aspect, with the os tarsale III (T3) distally and with T4 laterally. T1-2, T3 and T4 form the most distal row of bones in the tarsus and articulate with the

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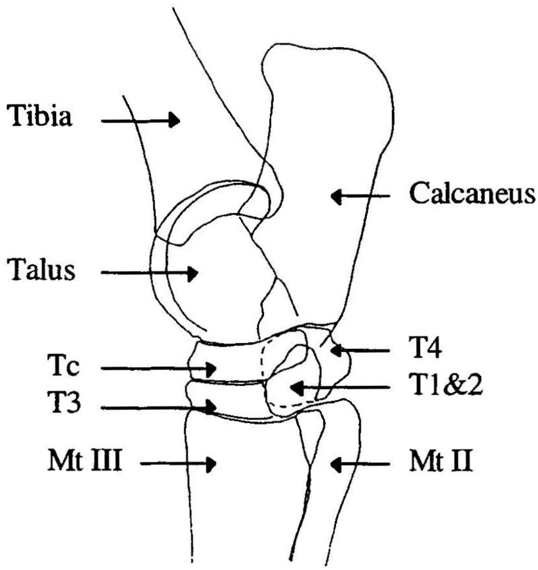
[1] Statistics from The Farmers Association of Iceland, 1997.

proximal surfaces of the os metatarsi II, III and IV, respectively. The bones are held together by numerous ligaments and a fibrous joint capsule.

Figure 1. Lateral view of the bones in the tarsal joint of the horse.



Nerves

The tibial, saphenous, and superficial and deep peroneal nerves innervate the tarsus. Two types of nerves, primary articular nerves and accessory articular nerves, innervate the appendicular joints. The primary nerves are independent and arise directly from the appendicular nerves, while the accessory nerves also innervate the muscles. The neurones innervate receptors with different functions within the joint and are classified in four categories (Caron 1996). Type 1 receptors are mechano-receptors and are stimulated by relatively mild stimuli. They are located in the superficial parts of the joint capsule most likely to be subjected to mechanical forces. Type 1 receptors function as monitors of joint motion and also contribute to arthrokinetic reflexes. Type 2 receptors are fast adapting mechano-receptors located in the inner layer of the joint capsule and in articular fat pads. These receptors are activated by motion and their activity is dependent on the rate and magnitude of the motion. Type 3 receptors are high threshold, slowly adapting mechano-receptors also capable of nociception. They modulate the reflex impulses from type 1 and type 2 receptors through inhibition of the muscles acting on the joint. Type 3 receptors are mainly found at the insertions of the articular ligaments. Type 4 receptors frequently occur in the periostium adjacent to the joint and in the joint capsule, but are less abundant in the subchondral bone and the synovium. Some sensory nerve endings are also present between the subchondral bone and the articular cartilage. In contrast to type 1-3 receptors, type 4 receptors are responsive to thermal and chemical stimuli as well as to mechanical influences. The signals from the receptors are transmitted by different types of nerve fibres and interact to produce impulses interpreted as pain.

Synovium & articular cartilage
The inner part of the joint capsule is outlined by the synovium. The synovium is responsible for the exchange of nutrition and waste products between the synovial fluid and the bloodstream. The synovial fluid is a viscous liquid consisting of an ultrafiltrate of plasma and of hyaluronan. It supplies the articular cartilage with nutrients and plays an important role as a lubricant in the joint. The articular cartilage is built up by a framework of collagen, proteoglycans and glycoproteins, and has a high water content. This gives the cartilage tensile and hydrostatic properties. During loading, the cartilage conforms to give optimal force distribution and improved stability. Fluid is exuded and forms a lubricating film between the opposing surfaces. The cyclic loading also serves to pump the joint fluid containing nutrients and waste products through the cartilage.

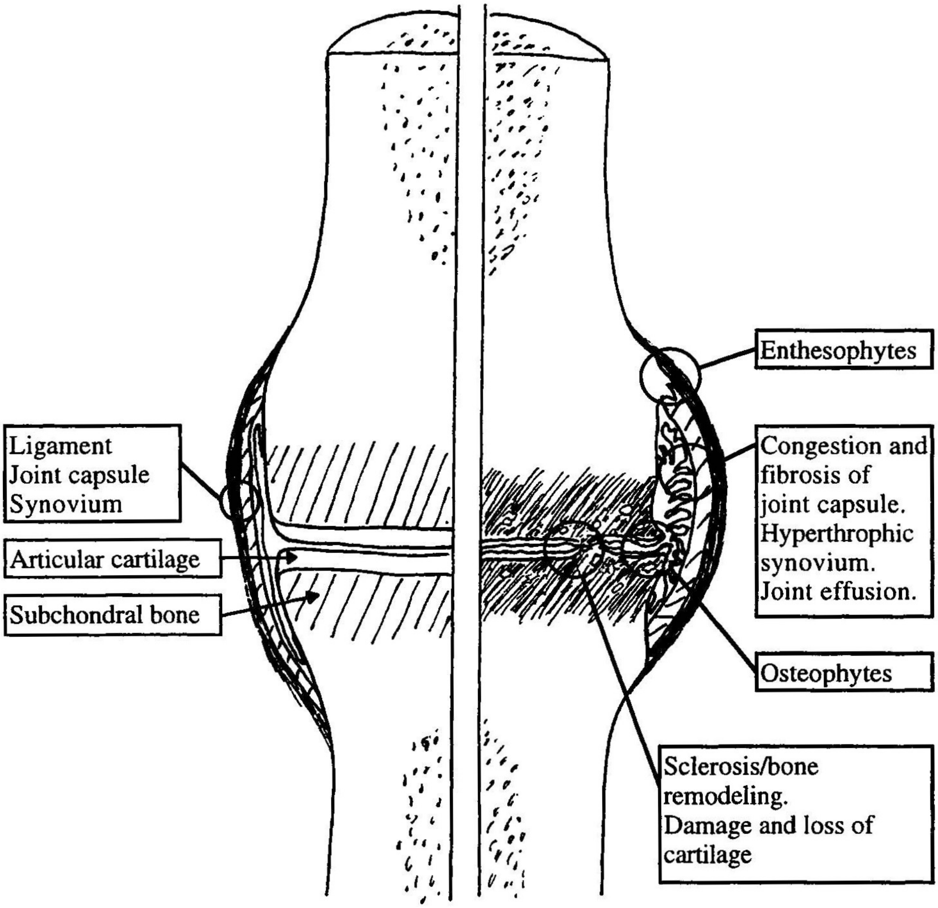
Pathophysiology

Goldberg (1918) reviewed the pathomorphological appearance of bone spavin. The gross lesions in ligaments, joint capsule, synovium, articular cartilage, subchondral bone and periostium described correspond well with the descriptions of DJD in the distal tarsus found in modern literature (Pool 1996). Pool (1996), however, provides histopathologic descriptions and proposed pathogenetic mechanisms for the development of DJD in the modern athletic horse. The gross lesions of DJD is illustated in Figure 2.

In the articular cartilage, three types of change are described. In foals, locations of thrombi in the subchondral bone have been observed. The significance of these defects is not clear. In mature horses, parallel defects termed "wearing lines" are a common finding. The chondrocytes and cartilage matrix along these lines are degenerated or necrotic. This condition may be self-limiting, but in more typical stages of DJD the lesions are accompanied by fibrillation, ulceration and loss of cartilage. In advanced stages, there is a total loss of cartilage and subchondral bone is exposed at the joint surface.

The increased loading of the athletic horse stimulates the trabecular subchondral bone to grow thicker and also leads to sclerosis. Although the sclerosis of the subchondral bone will increase its strength, it also reduces the elasticity of the bone and the capacity to absorb forces. Greater strain is thereby imposed on the cartilage. In advanced DJD, there is a loss of trabecular pattern and a more progressive bone turnover is present.

Figure 2. To the left a chematic picture of a normal joint and to the right a joint with DJD-lesions.



In DJD, changes occur in the fibrous part of the joint capsule as well as in the synovium. The fibrous part is oedematous and congested, and new fibrous tissue is formed that leads to reduced motility of the joint. The synovium undergoes hyperplasia and metaplasia, leading both to an obliteration of joint recesses and an alteration of synovial function.

Along the insertion of the joint capsule and at the insertion of the ligaments, new bone formation is a common finding. These changes are termed enthesophytes. At the edges of the joint surface, new cartilage and bone forms, known as osteophytes. In high-motion joints, the formation of osteophytes predisposes to small fractures, or chip fractures, at the joint margins.

DJD in low-motion high-load joints

Movement is essential for maintaining normal physiologic processes, structure and mechanical function in synovial joints. Immobilisation of joints leads to changes in cartilage metabolism and periarticular tissues (Golding and Ghosh 1983; Vanharanta 1983; Kallio 1988). The articular cartilage is rich in loosely bound water, which is the transport medium for nutrients and wastes to and from the cartilage. Cyclic loading during locomotion facilitates the transport of water with nutrients and waste products. Highly loaded joints with low motion, such as the PIT, CD and TMT joints, are therefore more likely to develop DJD. In the high-motion joint, the area under maximal load changes during locomotion. In the low motion joint, however, the area under maximal load is almost stationary under the same conditions.

The structural changes occurring in low-motion joints developing DJD differ from the changes found in DJD affecting high-motion joints and were outlined by (Pool 1996) as follows: "In DJD of high-motion joints, there is (1) chronic wearing away of articular cartilage that may progress from the joint surface to the subchondral bone, (2) sclerosis of the subchondral bone plate and spongiosa, (3) chronic synovitis, and (4) gradual loss in the range of motion due to progressive thickening of the joint capsule. By contrast, in DJD of low-motion joints at the site of maximal loading, one finds (1) full-thickness necrosis of the articular cartilage with little wearing, (2) focal destruction of the subchondral bony support, (3) an absence of synovitis, and (4) focal to complete bony ankylosis of the joint. Fibrosis of the joint capsule is an initial pathologic change in low-motion DJD and, along with pain, may be a major factor in further restricting the little motion that is normally present in the low-motion joint." On the basis of these findings, Pool suggested that the probable cause of the disease is trauma to the periarticular tissues. The trauma leads to inflammation that subsequently reduces mobility in the joint, followed by cartilage necrosis. The uncovered subchondral bone will then trigger a healing process resembling the healing of a long bone fracture.

Clinical signs and diagnostics

The complaints reported by horse owners are often related to the locomotor system and include unwillingness to perform in some gaits and stiffness or uneven movements (Moyer, Brokken et al. 1983). Sometimes, the horse has a tendency to break into a gallop that is difficult to control. A thorough clinical examination, including inspection, palpation, motion evaluation and flexion test of these horses, often reveals hind limb lameness associated with radiographic signs of DJD in the distal tarsus (Moyer, Brokken et al. 1983) (Stashak 1987) (Wyn-Jones 1988) (Todhunter 1992). One of the most common causes of hind limb lameness is DJD in the distal tarsus (Vaughan 1965) (Gabel 1983) (Bergsten 1983) (Barneveld 1983). Flexion test of the hind limb usually amplifies lameness in cases with DJD in the distal tarsus, although this finding is not consistent (Barneveld 1983). Some horses have a hard swelling on the medial aspect of the distal tarsus. Nerve blocks of the tibial, deep and superficial peroneal nerves and intra-articular anaesthesia of CD and TMT are often used as diagnostic aids (Lindsay, Taylor et al. 1981) (Stashak 1987) (Skarda 1991). Both types of anaesthesia generally decrease the grade of lameness in cases of DJD in the distal tarsus. Intra-articular anaesthesia is more specific since it desensibilises the injected joint alone, while the neural block desensibilises the entire limb distal to the block.

Degenerative joint disease (DJD) of the distal tarsal joints affects the centrodistal (CD), the tarsometatarsal (TMT) and, more seldom, the proximal intertarsal (PIT) joints (Barneveld 1983; Butler, Colles et al. 1993). As already mentioned, the clinical manifestation is variable and radiographic examination is considered essential for the diagnosis (Stashak 1987; Butler, Colles et al. 1993). Radiographic signs associated with DJD in the distal tarsal joints include periarticular osteophytes (Shelly and Dyson 1984; Butler, Colles et al. 1993), subchondral bone lysis or rarefaction (Butler, Colles et al. 1993; Park, Steyn et al. 1996), and narrowing and collapse of joint space or ankylosis (Shelly and Dyson 1984; Butler, Colles et al. 1993).

Scintigraphy has also proved to be a useful technique in diagnosing DJD in the distal tarsus (Font 1994). The method detects changes in the metabolic activity and is very sensitive. There is a good correlation between the scintigraphic and radiographic signs of DJD in the distal tarsus (Driesang and Bohm 1993) (Park, Steyn et al. 1996).

In an insured population of horses in Sweden (Bergsten 1983), bone spavin was the most frequent diagnosis of hind limb lameness in both large and small breeds. Among 58,200 insured horses, there were 353 claims (0.6%) on the grounds of bone spavin. Other diagnoses of hind limb lameness with large numbers of claims were gonitis and osteochondrosis. The femuropatellar and tibiotarsal joints are the most common locations of osteochondrosis in the equine (Trotter and McIlwraith 1981). In small breeds, however, osteochondrosis is rare (Bergsten 1983) (McIlwraith and Trotter 1992) and no report of osteochondrosis in the Icelandic Horse is found in the literature.

Aetiology

The aetiology of DJD in the distal tarsal joints is not clear, but has been considered to be multifactorial (Wyn-Jones 1988). The disease has been reported to be most common in mature horses that are ridden hard at a gallop, horses used for jumping, and in Western horses used for reining, roping and cutting (Gabel 1980). High frequencies of radiographic abnormalities in the distal tarsal joints have also been reported in German riding horses (Winter, Bruns et al. 1996) and in young, clinically sound trotters (Hartung, Munzer et al. 1983). Wyn-Jones (1988) considered the disease to be widespread in the general equine population. DJD in the distal tarsus has been related to poor hind limb conformation, e.g. sickle hocks and cow hocks, indicating an inheritable component (Rooney 1969; Gabel 1980; Barneveld 1983; Stashak 1987). A genetic predisposition for DJD in the distal tarsus was reported in Dutch warmbloods (Barneveld 1983), and a heritability of $h^2 = 0.02 - 0.04$ was reported in German riding horses (Winter, Bruns et al. 1996).

Therapy

During the last century, methods of treating DJD in the distal tarsus have been reviewed by several authors (Vennerholm 1900; Thomas 1912; Wamberg 1955; Taylor 1977; Barneveld 1983). Thomas (1912) stated that the treatment of DJD in the distal tarsus is probably as old as the disease itself. On the orders of Emperor Constantinus Porphurogenitas (913-959), ointment and bandage were prescribed as treatment for spavin. Firing (Russius 1535) and the application of a fontanelle (Tostlöwen 1698) date from the Middle Ages. During the 19th century, several surgical approaches were described; tenectomy of the medial branch of the m. tibialis cranialis tendon (Abildgaard 1832), periostomy (Sewell 1835; Peters 1879) and neurectomy of the tibial, superficial and deep peroneal nerves. During the last century, Wamberg (1955) launched a peripheral neurectomy technique. Adams (1970) introduced an arthrodesis technique whereby parts of the articular cartilage were removed in the distal tarsal joints. This technique has been widely used and modified (Edwards 1982) (McIlwraith and Turner 1987) (Wyn Jones and May 1986) (Barber 1984).

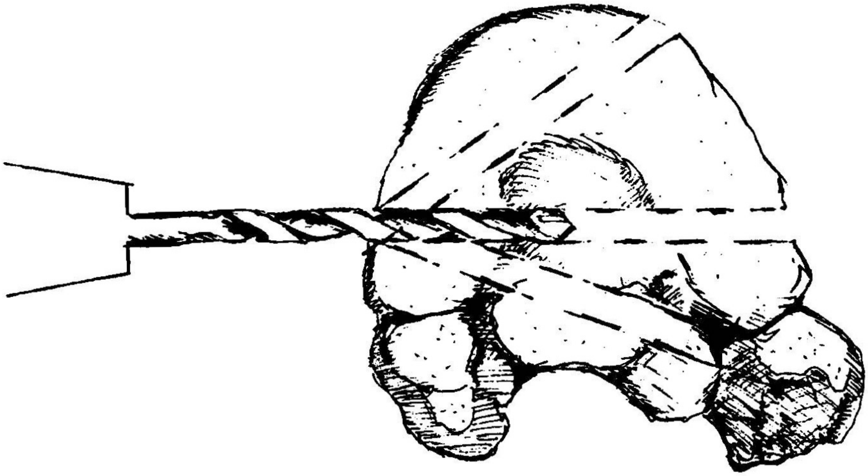
Fenestration is a surgical approach described in the horse and is based on the theory that the affected bones have an increased intraosseous pressure (Sonnichsen and Svalastoga 1985). In this technique, holes are drilled through the intertarsal and proximal metatarsal bones to reduce the pressure and thereby relieve the pain. The recovery rate after fenestration was initially reported to be 75%, but in a more recent material it was found to be 50%.

In recent years, intra-articular injection of monoiodoacetate has been introduced (Bohanon, Schneider et al. 1991) and experience from a clinical material reported (Bohanon 1995). Monoiodoacetate is toxic and causes necrosis of the articular cartilage: a bony fusion of the injected joint is thereby stimulated.

Both surgery and monoiodoacetate injections were practised as therapy for bone spavin at the Large Animal Clinic, SLU. The outcome was similar for the two treatments. However, a substantial number of horses experienced severe pain after injection of monoiodoacetate, even those premedicated with NSAID's. Also, the anatomic variations regarding communication between the synovial compartments in the tarsus need to be considered (Bell, Baker et al. 1993; Dyson and Romero 1993). To avoid injection of monoiodoacetate into undesired joints and synovial sheaths, the anatomy has to be evaluated with regard to such communication. Due to the occurrence of complications and a lack of therapeutic benefit, compared to surgical treatment, the monoiodoacetate treatment was abandoned at the Large Animal Clinic at SLU

(Ronéus 1994). At present, the treatment regimes for bone spavin at SLU consist of conservative treatment, systemic and intra-articular anti-inflammatory medication and surgical intervention (Figure 3).

Figure 3. Proximal ends of the right metatarsal bones. Surgical technique: A 3.2 mm drill-bit was inserted from the medial aspect and three holes was made along the plane of the tarsometatarsal and centrodistal joint respectively.



Background to this thesis

Due to an increasing caseload of bone spavin in Icelandic Horses at SLU, several questions were raised regarding the disease. How common is the disease in the population? How many horses with radiographic signs of bone spavin are free of lameness or other locomotor-related signs? How good are we at diagnosing this disease? Does conformation influence the occurrence of bone spavin? Magnusson (1990) reported a relationship between conformation and soundness in 4-year-old standardbred trotters. Arnason (1984) reported a relatively high heritability for conformational and performance traits in Icelandic Horses. If any such trait could be correlated to bone spavin, then it should be possible to reduce the prevalence of bone spavin by taking appropriate measures in breeding. Alternatively, is there a genetic predisposition to the disease itself? Dolvik (1994) found a correlation between training and carpitis in coldblooded trotters. Is the development of bone spavin in Icelandic Horses correlated to the workload, the type of use of the horse or its riding traits in a similar fashion? Are current treatments for the disease effective? Numerous treatment modalities have been practised over the years. On the basis of these and many other questions, a large-scale research project was initiated. This thesis is a part of that project.

Aims

- To estimate the prevalence of hind limb lameness and degenerative joint disease in the distal tarsus in the population of Icelandic Horses in Sweden and Iceland.
- To evaluate the relationship between hind limb lameness and radiographic signs of degenerative joint disease in the distal tarsus in the Icelandic Horse.
- To identify risk factors, both management-related and intrinsic, for hind limb lameness and degenerative joint disease in the distal tarsus in the Icelandic Horse.
- To compare the effects of conservative vs. surgical treatment in lameness due to degenerative joint disease in the distal tarsus in the Icelandic Horse.

Materials and methods

Study design

Cross-sectional investigations (Papers I-IV) were performed to assess the prevalence of (Paper I), relationship between (Papers II and III) and risk factors for (Papers I and IV) radiographic signs of DJD in the distal tarsus and of hind limb lameness. Clinical cases were studied to assess the possible benefit of surgical treatment vs. conservative treatment for lameness due to DJD in the distal tarsus (Paper V).

Horses

A total of 1029 Icelandic horses, 668 geldings, 321 mares and 40 stallions were studied in this thesis. Data were collected through physical and radiographic examinations of all individual horses and by interviewing the owner or trainer of each horse. For studies I and II, eleven different farms in Sweden were selected, all Icelandic Horses at these farms being investigated. In total, data on 379 horses aged 1-19 were obtained. In studies III and IV, 17 sires representing all major breeding lines in Iceland were selected. Offspring (n=420) 6-12 years of age by these sires, together with other horses (n=194) in the same age-range in Iceland, were examined. For study V, 36 horses from the caseload at the Large Animal Clinic, SLU, were selected.

Interviews

Information on each horse's identity, use, training and riding qualities was obtained from the owner and/or trainers by interviews at the time of examination. Based on experience from studies I and II, the protocol was revised before being used in studies III and IV. The questions focused on the horses' physical activity and ability both during the breaking-in period and during the last two years prior to the investigation.

Physical examinations

Height at the withers was recorded in studies I and II. In studies III and IV, the body measurements were extended to include height at the croup, width between the thighs, thickness of the right tarsus, and tarsal angle. The sturdiness of the frame was classified as light, intermediate or heavy. Hind limb conformation was evaluated from the side and classified as normal, sickle or straight, and was classified from behind as normal, hock narrow or hock wide (Stashak 1987) (I-IV). The medial aspect of the tarsus was palpated and swelling recorded. Hind limb lameness was evaluated while trotting the horse in hand on a firm surface 25-30 metres back and forth in a straight line, after which a flexion test was performed by flexion of each tarsus for one minute and repeating the above motion evaluation (Stashak 1987) (I-V). All horses in study V were lameness cases at the Large Animal Clinic, SLU, and all of them had been subject to a lameness investigation. To verify the location of pain in the distal tarsus, diagnostic methods included intra-articular anaesthesia in eleven cases. Lameness was reduced in all cases where intra-articular anaesthesia was performed.

Radiographic examinations

For studies I-II, one standard dorsolateral-plantaromedial oblique view (Pl45°L-DMO) was recorded from each tarsus. In studies III-IV, three projections were used; latero-5°-proximal-mediodistal (L5°Pr-MDi), dorso-35°-lateral-plantaromedial oblique (D35°L-PlMO) and plantaro-45°-lateral-dorsomedial oblique (Pl45°L-DMO). The sensitivity of using one (I-II) or three (III-IV) projections compared to a set of four projections in order to detect DJD in the distal tarsus were evaluated by Eksell (1999) and found to be 89% and 100% respectively.

In study V, all radiographic examinations were performed at the Department of Clinical Radiology, SLU. The radiographic diagnosis was based upon films from four standard projections (L5°Pr-M, D-Pl, DiPl45°L-DMO, D35°L-PlMO). In nine cases, with marked radiographic changes, the examination was limited to a reduced number of projections. Further, the diagnosis of bone spavin was confirmed by scintigraphy in 25 of the 36 horses.

Radiographic signs of DJD in the distal tarsus involving half a joint space or less were graded 1; more than half but not more than one joint space involved was graded 2, and more than a total of one joint space involved was graded 3 (II, III, V).

Treatment

Surgery was performed using a drill tract technique (Figure 3) (McIlwraith and Turner 1987) on one or both limbs. It consisted of tenoectomy of the medial branch of tibialis cranialis tendon and the drilling of three holes along the plane of the centrodistal joint (CD) and the tarsometatarsal joint (TMT). Post operatively horses were confined to stall rest for fourteen days during wound healing. Besides the first two weeks of post operative care, all horses, surgically treated and non-surgically treated, were designated to a common convalescence program (V).

Data analysis

The JMP® 3.1 software package (SAS 1995) and manual calculations were used to analyse data.

Studies I & IV

Bivariate and multivariate logistic regression analyses (Hosmer 1989) were used to identify association between tested potential risk factors and the outcome variables lameness and radiographic signs of DJD in the distal tarsus.

Studies II & III

The x^2-test and the x^2-trend test (Altman 1991) were used to assess the relationship between clinical signs/clinical tests (lameness at presentation, lameness after flexion test and palpable abnormalities) and radiographic signs. In addition, rate of agreement and rate of disagreement were calculated for the clinical tests (II). Logistic regression analysis was used to determine the relationship between age (II, III) and gender (III) and the clinical and radiographic findings. Logistic regression analysis was also used to test radiographic appearance as a predictor for lameness.

Study V

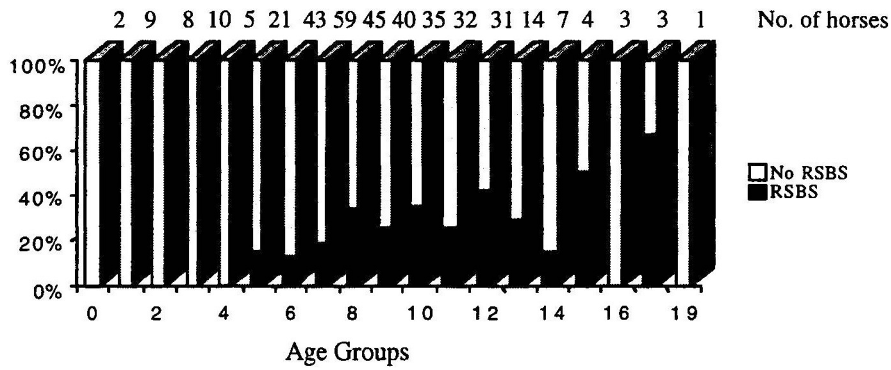
Bivariate and multivariate logistic regression analysis was used to assess difference in recovery rates between the two treatment groups.

Results & Discussion

Prevalence of DJD in the distal tarsus

Radiographic signs of DJD in the distal tarsus were found in 23% (I) and 30.3% (III) of the horses in the two investigated populations. Radiographic changes predominated in the CD and TMT joints The PIT joint was involved in 25 of the 441 affected limbs. Approximately half of the affected horses had radiographic changes bilaterally. The prevalence of hind limb lameness after flexion test was 25% in the Swedish population (II) and 32.4% in the Icelandic population (III). No horses with radiographic signs of DJD in the distal tarsus or hind limb lameness were found in the age-span 0-4 years of age (I-II), (Figure 4).

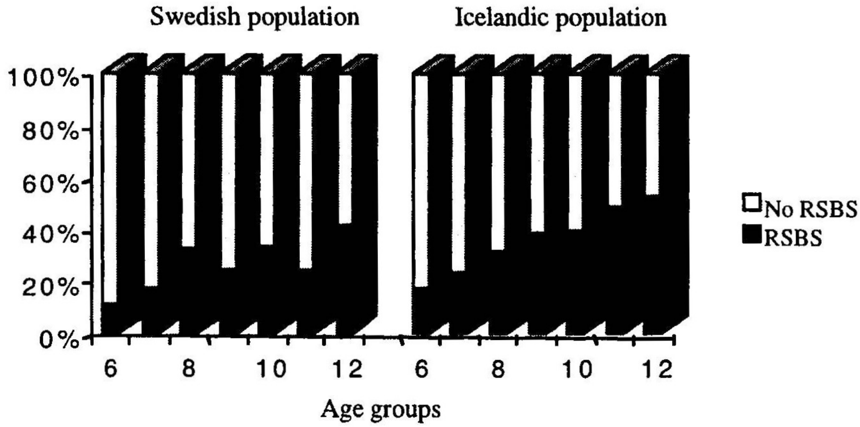
Figure 4. Prevalence of radiographic signs of DJD in the distal tarsus in 372 Icelandic Horses, 1-19 years of age, in Sweden (I).



With horses 0-5 years excluded, the prevalence in the two investigated populations was similar (Figure 5). The prevalence of radiographic changes increased significantly from 5 to 12 years of age. No association was seen between age and lameness (III). Data from an animal insurance company indicate that the prevalence of the disease varies between different breeds. The proportion of claims for bone spavin among the insured population of Swedish warmbloods, ponies and mixed breeds ranged between 0.01 and 0.02 % (Bergsten 1983) while the proportion of claims for bone spavin in the insured population of Icelandic horses was 1.2% (Odenhall 1996). A frequency of 1.2 % for the disease was also found in horses admitted to the Ohio University Veterinary Hospital (Gabel 1983), representing a mixture of breeds. In contrast, the prevalence of RSBS among Icelandic Horses in this study was 23% and 30.3%, which indicates a predisposition to the disease in Icelandic Horses.

The localisation of DJD found in these studies is in good agreement with the findings in other studies (Barneveld 1983; Roethlisberger and Ueltschi 1989).

Figure 5. Prevalence of RSBS in the age span 6-12 years in the investigated populations of Icelandic Horses in Sweden and in Iceland.



Selection bias

No complete register of Icelandic horses is available for Sweden or Iceland and therefore no random sample could be obtained for the estimation of prevalence. To minimise the risk of selection bias in studies I-II, all horses on the farms included were examined. In the investigation in Iceland (III, IV) the interview included questions regarding anamnesis of the horses and whether the owner/trainer suspected that the horse had DJD in the distal tarsus or not. The calculations were thereafter performed both with all horses included and then after excluding horses with a history of hind limb lameness and/or radiographic signs of DJD in the distal tarsus. In doing so, the results were not significantly altered.

With these precautions and the use of two totally different selection methods revealing similar prevalence, it is proposed that the samples are representative of the Swedish and Icelandic populations of Icelandic horses and that the prevalence of DJD in the distal tarsus and hind limb lameness is high in both populations.

Relationship between lameness and radiographic changes

In the Swedish population, radiographic signs of DJD in the distal tarsus were found in 45% (n=53) of the horses with palpable abnormalities, in 53 %

(n=23) of those presented with lameness, and in 44% (n=41) of the horses that were positive after flexion test (II). This corresponds well with the findings in the Icelandic population. The corresponding figures found in the Icelandic population were 54% (n=100), 66% (n=27) and 50% (n=101), (III). Horses with radiographic signs had a fourfold risk of being lame compared to horses without such signs (OR=4.0, P<0.001), (III).

The probability of finding radiographic changes increased significantly with increased grade of the disease according to palpation, lameness and lameness after flexion test in study II. The inverse trend was not found. Among horses with radiographic signs, the prevalence of lameness and palpable abnormalities did not increase significantly with increasing radiographic grade. Likewise, in study III, no associations were found between grade of radiographic signs and prevalence of clinical signs and vice versa. This means that once a horse is radiographically positive, the grade of the radiographic changes cannot be used to predict lameness.

By using palpation, lameness evaluation and flexion test, 75% of the horses with radiographic changes were identified (II).

Of the eighty-four (43+41) horses lame at presentation (II, III), 11% (n=9, 2+7) were free from RSBS, negative at flexion test and free from palpable abnormalities. Of the 276 (181+95) horses with positive flexion test 30% (n=85, 63+22) had no RSBS and no palpable abnormalities. The reason for lameness and positive flexion test in these horses, was not elucidated in this thesis. However, more sensitive diagnostic methods, such as intraarticular anaesthesia or scintigraphy, might indicate inflamation in the distal tarsus even in some of these specimens.

Risk factors

Among the conformation factors tested, only *tarsal conformation* and *tarsal angle* were significantly associated with RS (Table 1). Only *height at the croup* was associated with lameness. A higher prevalence of RS was found in horses with *sickle hocks* (I) and in horses with a smaller *tarsal angle* (IV), while a higher prevalence of lameness was found in horses that were lower at the croup (IV).

Magnusson (1985) showed a relationship between tarsal conformation and soundness in a material of 500 standardbred trotters. Before the studies by Magnusson, little research on conformation and soundness was found. However, the issue has probably been discussed ever since man domesticated the horse. The findings regarding tarsal conformation and soundness in this study correspond with the findings of Magnusson, as well as with the opinions of several other authors (Rooney 1969; Stashak 1987; Wyn-Jones 1988). There is no obvious explanation for the finding that horses, that are higher at the croup, have a lower prevalence of lameness. This finding was also somewhat contradictory to the finding in study I, where a tendency for taller horses to have a higher prevalence of RS was found. The ratio between height at the withers and height at the croup was also tested as a risk factor, but no association to *RS* or *lameness* was found (IV).

The assessment of conformational traits by ocular inspection is a hazardous task, as demonstrated in this work by the large discrepancy in the trait *tarsal conformation*. In the Swedish population, 20% were found to have *sickle hocks* and 60% were classified with the same trait in the Icelandic population. Further, no association was found between the trait *tarsal conformation from the side* and *tarsal angle*. Even though a measuring instrument increases the possibility of an objective determination with good repeatability, the risk of error is not eliminated. The subjective character of ocular judgement, together with the small difference in *tarsal angle*, 0.8 mm between horses with RS and horses free from RS found in this study, means that the prospects of reducing the prevalence of DJD in the distal tarsus by determination of tarsal conformation must be very small.

Table 1. Summary of factors tested as risk factors for *lameness* and *RS* (I, IV).

Intrinsic factors	Lameness/RS	Factor / Association
Sire	Lameness	
Gender		No
Age	RS	Pos.
Gaits	Lameness	Four-gaiter / neg.
Temperament		No
Front limb action		No
Sturdiness of frame		No
Tarsal conformation	RS	Sickle hock / pos.
Tarsal angle	Lameness	Neg.
Height at withers (hc)	RSBS	Weak pos.
Height at croup (hw)	Lameness	Weak neg.
Hc/hw		No
Width of thighs		No
Width of tarsus		No

Environmental factors	Lameness/RS	Factor / Association
Birthplace	RS	Neg.
Examination place		No
Housing first years of life		No
Broken by amateur/professional		No
Age when broken to saddle		No
Entered at stud show	Lameness	Not shown / pos.
Competing status		No
Training intensity		No
Tour trekking		No

The factors *broken to saddle at 6 years of age or older* and *not entered at stud show* were both positively associated with lameness. It has been argued among horse breeders that the trend towards training and showing younger horses has led to an increased prevalence of DJD in the distal tarsus. Our findings do not support such a theory. However, no other factors reflecting workload, training intensity or type of work were significantly associated with *RS* or *lameness*. On the other hand, a strong correlation between age and RS was found. The first cases of RS were found in the 5-year-old group (I), after which the prevalence increased with increasing age (I, III). Hence, in a great number of horses the onset of DJD in the distal tarsus occurs during the same period of time as breaking-in and initial training. Also, the prevalence of RS increases during the most active period of the horse's life. Nevertheless, there is reason to believe that DJD in the distal tarsus is related to the quality and quantity of strain to which the horses are subjected. In this study, however, we have not been able to identify any difference in training intensity or in the use of the horses regarding the prevalence of DJD in the distal tarsus or hind limb lameness.

The true significance of workload remains to be answered. We have found a close relationship between age and DJD in the distal tarsus. Both the quality and quantity of work vary with age. The breaking-in of Icelandic Horses usually takes place during the four and five-year-old period. As horses grow older, the physical demands as well as the additional amount of work done by the horses increases simultaneously with the prevalence of DJD in the distal tarsus. We have no knowledge of what the prevalence of DJD in the distal tarsus is in a population of horses that have not been ridden at all. Such information would clarify the importance of physical strain for the development of DJD in the distal tarsus.

The Icelandic horse measures 136.4 cm (SD=3.5) at the withers (IV). Other horse breeds of similar size are classified as ponies by European standards. Children or very small, light adults ride ponies of this size. In contrast, the Icelandic Horse is ridden by full-grown people. The relatively small size of the horse limits its carrying capacity. In Iceland, this seems to be compensated by maintaining a surplus of horses in reserve. By keeping a group of horses rather than one or two, the negative effects of DJD in the distal tarsus are most probably reduced.

The factor *birthplace* was associated with *RS* (IV). *Birthplace* was included in the analysis in order to check for bias connected with the part of the country in which the horses were raised. As far as we know, there is no difference between regions in Iceland regarding forage, soil or the management of farms that would influence the association between *birthplace* and *RS*.

None of the factors influencing riding qualities was associated with an increased prevalence of *RS* or *lameness*. For instance, no indication of toelt being detrimental to the tarsus was found. In contrast, *four-gaiter* horses had a lower prevalence of lameness. We believe that this reflects the subjective character of gait classification and that it is more likely that horses affected by DJD in the distal tarsus will be classified as having difficulties with toelt than that *four-gaiter is* a protective factor against lameness.

Sire was associated with *lameness* but not significantly associated with *RS* (IV). Dolvik and Gaustad (1996) reported a genetic disposition to lameness in 4-year old standardbred trotters. Obviously, different individuals have different genetic capacity to adapt to the requirements imposed on them.

Effect of treatment (V)

The two treated groups were equivalent with regard to breed, age, duration and degree of lameness, and radiographic appearance prior to treatment. Mean follow-up time was 22 months for the surgery group and 19 months for the non-surgery group. In the surgery group, 65% (n=13) of the horses improved and in the conservatively treated group, 56% (n=9) improved. Complete recovery was seen in 50% (n=10) in the surgery group and in 31% (n=5) of the horses in the non-surgery group. The difference in recovery rates between the two treated groups was not statistically significant. However, due to the relatively small number of treated horses and to limitations in study design, statistical calculations were not really applicable. Nevertheless, statistics were compiled and presented together with an eligible study design. In earlier studies, horses not responding to conservative or other non-surgical treatment regimes were selected for surgical treatment. The recovery rate after surgery found in this study was somewhat lower than those reported by others (Adams 1970), (Edwards 1982), (Barneveld 1987) (Dechant, Southwood et al. 1999). The strength of the present study is that the material was uniform with regard to breed, age, duration of clinical signs, degree of lameness and grading of radiographic signs. All horses in the two treated groups were assigned a common convalescence program, the two different treatment strategies being performed during the same time period and at the same clinic. Nevertheless, questions about the effectiveness of surgical treatment remain. In this study, there is an indication that surgery is slightly superior to non-surgical treatment, but the number of treated horses was too small to support a reliable conclusion and the allocation to the two treatment groups was not randomised. Other reports where the same surgical technique was used appear to suffer from even greater limitations.

General discussion

This study has revealed a high prevalence of bone spavin and hind limb lameness in the population of Icelandic Horses. A strong association between the radiographic signs of DJD in the distal tarsus and hind limb lameness was found, and the prevalence of *RS* increased with age. The observation by practitioners that there is a presence of Icelandic Horses with *RS* but no *lameness* was confirmed in this study. At the same time, this study revealed that horses with *RS* had a fivefold risk of being lame at presentation and a fourfold risk of being lame after flexion test compared to horses free from *RS*. From these findings, it is concluded that horses with *RS* experience a higher risk of becoming lame. In this study, it was also found that the extent and appearance of *RS* were poor predictors for both the presence of lameness as well as the degree of lameness. Therefore, a thorough clinical examination combined with a radiographic examination of the tarsus, bearing in mind the age of the horse, is needed in order to evaluate the present condition in a horse. Such an examination will not provide all the answers, but will definitively help in making a risk estimation regarding bone spavin and associated lameness.

The analysis of risk factors revealed a strong correlation between radiographic signs of bone spavin and age, and a strong correlation between sire and hind limb lameness. Hence, there is also an indication of a genetic disposition to bone spavin. This finding agrees with heritability studies performed in the same Icelandic Horse population (Björnsdottir, et al. 2000). Björnsdottir reported medium high heritability for *lameness* and low heritability for *RS*. However, it was pointed out that the strong correlation between age and *RS* might lead to an underestimation of the heritability of *RS*. Futher studies are in progress concerning the heritability of *RS*.

Among the other factors tested in the present study, none seems to be very suitable for use in breeding and management programs with the aim of limiting bone spavin and associated lameness. On the other hand, a number of factors alleged to increase the tendency to develop bone spavin have been ruled out as possible risk factors. There was no indication in this study that any of the traits that are evaluated and encouraged in the existing system of selecting breeding stock, that we tested, were detrimental to the tarsus. Also, there was no indication that training and showing in itself are harmful to four and five-year-old horses.

In the future, it would be of interest to investigate Icelandic Horses on the basis of different combinations of clinical, radiographic and scintigraphic signs of DJD in the distal tarsus. In a longitudinal study, further details regarding the development and progression of the disease could be obtained. We still do not know why there is a linear increase in the prevalence of RSBS with age, at the age of five years and older, while the prevalence of hind limb lameness is not correlated to age in the same fashion. Also, the relatively high prevalence of horses with RSBS free from signs of hind limb lameness leads to the question of why these horses are not lame. Are there differences in the radiographic appearance not accounted for in this study? Also, the correlation between clinical signs and scintigraphic signs needs to be evaluated. The application of more objective methods of recording locomotion might reveal aberrations in these horses that are not detected under clinical circumstances. Other means of measurement might also prove helpful, such as the analysis of inflammatory markers in the synovial fluid. Are there different levels of neurotransmitters in joints with DJD in limbs, that are lame compared to joints with DJD in limbs that appear sound? The study of intra-articular metabolism and kinetic and kinematic parameters are two main directions for further research in this area. Possibly, a combination of the two would be preferable.

Summary & Conclusions

- The prevalence of DJD in the distal tarsus is high in the Swedish and Icelandic populations of Icelandic Horses.
- There is a strong relationship between hind limb lameness and radiographic signs of DJD in the distal tarsus.
- Signs permitting the detection of DJD in the distal tarsus are first seen in the age group when the horses are broken to saddle. Thereafter the prevalence increase as horses go on to increased levels of use.
- There is a genetic disposition to hind limb lameness associated with radiographic signs of DJD in the distal tarsus.
- The benefit of surgical treatment versus non-surgical treatment for lameness due to DJD in the distal tarsus remains uncertain.

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Acknowledgements

To Professor Kristina Narfström my supervisor for supervising (!) me in spite of the unfathomable distance between the secrets of the retina and the deterioration of the distal tarsus in equines.

To Associate Professor Johan Carlsten, co-supervisor, for his tremendous enthusiasm and support during this work.

To Bengt Ronéus, co-author, mentor, friend. One day you said to me in your very strait-forward way: "We are going to do some research regarding bone spavin in Icelandic Horses and YOU are going to be a part of it!" Thanks for supporting and encouraging me in my carrier and, during your time at the large animal clinics, for teaching me a lot of hands-on surgery.

To Professor Arne Lindholm for once recruiting me to the Department of Medicine and Surgery, three days before for my final DVM-examination. I really had no such plans (I was to busy studying for my exams to have any plans).

To Professor Stig Einarsson for supervising my very first research project "Fertility in mares with special respect to insemination month", and for making me realise that research can be fun.

To Professor Peter Lord for constructive comments on manuscripts.

To Per Eksell co-author and friend for sharing (room, life, ideas, etc.) with me during the last 1,5 years when this thesis was completed.

To Henrik Ulhorn for good company and for help with the illustrations.

To Jens Häggström former classmate, co-author, and friend for helping out with the impossible theoretical parts, just as during vet. School.

To Hans Brostöm for his part in initiate this work (and for not doing what you threatened me to do at the bar-desk during your own dissertation party).

To Sigridur Björnsdottir my co-author and "sister" on Iceland, for all the good work and all the memorable moments experienced along the way.

To Helgi Sigurdsson, co-author and friend, rapid in though and action. Without your experience and your contacts among horsepeople in Iceland this study would not have been possible.

To all the owners and trainers of the horses investigated for this study.

To the participants in FORSK for your trust in me, making it possible for me to complete this work.

To Professor Mats Forsberg, head of the department and to Göran Sandh head of the Large Animal Clinics both for giving me slack from my duties at the clinics and to Göran for teaching me how to deal with the challenge encountered in the abdomen of a colic horse.

To everybody at the Department of Large Animal Clinical Sciences and at the Department of Clinical Radiology, for providing the coarse but good-humoured and hearty atmosphere to work in.

To Rolf, my father, for encouraging me to "get a solid education".

To Brita, my mother, for being just that.

And finally,

To Anna, my love, for arranging the party.

Thank You All!

Uppsala, March 2000

Mats

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ISSN 1401-6257
ISBN 91-576-5918-4