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Survey of Articular Cartilage Injury of Stifle Joints in 323 Dogs Presented for Surgery in Chiang Mai, Thailand, during

Korakot Nganvongpanit

Terdsak Yano

Original Article

Survey of Articular Cartilage Injury of Stifle Joints in 323 Dogs Presented for Surgery in Chiang Mai, Thailand, during 2006-2012

Korakot Nganvongpanit[1,2*] Terdsak Yano[3]

Abstract

The purpose of this study was to report the incidence of articular cartilage injury of the stifle joint in 323 dogs found during surgery at orthopedic clinics in Chiang Mai, Thailand, from October 2006 to July 2012. A total of 44 dogs (13.6%) had cartilage lesions. Surgical operations in this study included the corrections of anterior cruciate ligament (ACL) rupture (14.2%), distal femur fracture (15.2%), and patellar luxation (66.6%), and the removal of the IM pin from the tibia (4%). Cartilage injury was found in 1 of the 49 dogs with ACL rupture (2.17%, OR= 0.124); 3 of the dogs with distal femur fracture (6.12%, OR= 0.371); 28 of the 215 dogs with patellar luxation (13.02%, OR= 0.861); and 12 dogs of the 13 dogs with tibial IM pin to be removed (92.31%, OR= 104.250). In conclusion, high respective incidence of articular injury was found in the removal of IM pin from the tibia, patellar luxation, femoral fracture, and anterior cruciate ligament rupture surgical operations, respectively.

Keywords: articular cartilage injury, dogs, risk factors, stifle joint

[1]*Bone and Joint Research Laboratory, Department of Veterinary Biosciences and Public Health, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50100, Thailand*
[2]*Materials Science Research Center, Faculty of Science, Chiang Mai University, Chiang Mai 50200, Thailand*
[3]*Department of Food Animals, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50100, Thailand*
***Corresponding author: E-mail:** korakot.n@cmu.ac.th; korakot_n@hotmail.com*

บทคัดย่อ

การสำรวจการบาดเจ็บของกระดูกอ่อนผิวข้อเข่าในสุนัขที่เข้ารับการผ่าข้อเข่า 323 ตัวในจังหวัดเชียงใหม่ ประเทศไทย ระหว่างปี 2006-2012

กรกฎ งานวงศ์พาณิชย์[1, 2*] *เทิดศักดิ์ ญาโน*[3]

วัตถุประสงค์ของการศึกษาครั้งนี้เพื่อรายงานการเกิดการบาดเจ็บของกระดูกอ่อนผิวข้อเข่าในสุนัขจำนวน 323 ตัวซึ่งตรวจพบในขณะผ่าตัดข้อเข่าในคลินิกออร์โธปิดิกส์ จังหวัดเชียงใหม่ ประเทศไทยระหว่างเดือนตุลาคม 2006 ถึงเดือน กรกฎาคม 2012 จากการศึกษาพบสุนัข 44 ตัว (ร้อยละ 13.6) มีการบาดเจ็บของกระดูกอ่อนผิวข้อเข่า ซึ่งการผ่าตัดข้อเข่าในการศึกษานี้ประกอบด้วยการผ่าตัดแก้ไขการขาดของเอ็นไขว้หน้า (ร้อยละ 14.2) การผ่าตัดแก้ไขการแตกหักของกระดูกต้นขาหลังส่วนปลาย (ร้อยละ 15.2) การผ่าตัดแก้ไขสะบ้าเคลื่อน (ร้อยละ 66.6) และการผ่าตัดเพื่อเอาลวดแข็งในโพรงกระดูกหน้าแข้งออก (ร้อยละ 4) การบาดเจ็บของกระดูกอ่อนผิวข้อในการผ่าตัดแก้ไขการขาดของเอ็นไขว้หน้าพบ 1 ตัวจาก 46 ตัว (2.17%, OR= 0.124) การผ่าตัดแก้ไขการแตกหักของกระดูกต้นขาหลังส่วนปลายพบ 3 ตัวจาก 49 ตัว (6.12%, OR= 0.371) การผ่าตัดแก้ไขสะบ้าเคลื่อนพบ 28 ตัวจาก 215 ตัว (13.02%, OR= 0.861) และการผ่าตัดเพื่อเอาลวดแข็งในโพรงกระดูกหน้าแข้งออกพบ 12 ตัวจาก 13 ตัว (92.31%, OR= 104.250) จากการศึกษาครั้งนี้พบการบาดเจ็บของกระดูกอ่อนผิวข้อสุนัขสูงในการผ่าตัดเพื่อเอาลวดแข็งในโพรงกระดูกหน้าแข้งออก รองลงมาเป็นการผ่าตัดแก้ไขสะบ้าเคลื่อน การผ่าตัดแก้ไขการแตกหักของกระดูกต้นขาหลังส่วนปลาย และการผ่าตัดแก้ไขการขาดของเอ็นไขว้หน้าตามลำดับ

คำสำคัญ: กระดูกอ่อนผิวข้อบาดเจ็บ สุนัข ปัจจัยเสี่ยง ข้อเข่า

[1]*ห้องปฏิบัติการวิจัยกระดูกและข้อในสัตว์ ภาควิชาชีวศาสตร์ทางสัตวแพทย์และสัตวแพทย์สาธารณสุข คณะสัตวแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ อ. เมือง จ. เชียงใหม่ 50100 ประเทศไทย*

[2]*ศูนย์วิจัยวัสดุศาสตร์ คณะวิทยาศาสตร์ มหาวิทยาลัยเชียงใหม่ อ.เมือง จ.เชียงใหม่ 50200 ประเทศไทย*

[3]*ภาควิชาสัตว์บริโภค คณะสัตวแพทยศาสตร์ มหาวิทยาลัยเชียงใหม่ อ. เมือง จ. เชียงใหม่ 50100 ประเทศไทย*

***ผู้รับผิดชอบบทความ E-mail:** korakot.n@cmu.ac.th; korakot_n@hotmail.com*

Introduction

Articular cartilage injury is one of the most important joint diseases in dogs. This injury has been implicated as a risk factor for the development of knee osteoarthritis (OA) (Taskiran et al., 1999; Buckwalter and Brown, 2004; Natoli and Athanasiou, 2009). One of the main problems regarding this injury is that clinical signs are often not apparent until the disease has progressed to an advanced stage. In healthy joint, articular cartilage plays an importance role in pain-free and smooth movement. Previous study (Brown and Shaw, 1984) showed daily sustain forces of 1-2 megapascals (Mpa). Articular cartilage comprises a large volume of water; 65-85% of total weight. The major components of cartilage matrix are collagen type II, 75% dry tissue weight; and aggrecan-proteoglycan molecule, 20-25% dry tissue weight. Other minor components are chondrocytes, oligomeric protein, and thrombospondin. Those components are responsible for cartilage homeostasis (Mow et al., 1984). Articular cartilage is an avascular structure which shows poor wound healing process; moreover, this structure lacks a nerve supply. Injury to the articular cartilage causes no pain; hence the animal may likely not show clinical signs until the lesion has progressed deep into the subchondral bone, which has both vascular and nerve supply.

Human studies have shown that joint injuries may include direct and indirect articular cartilage impact loading, ligament injury, meniscal tear, joint luxation, or intraarticular fracture (Taskiran et al., 1999; Buckwalter and Brown, 2004; Natoli and Athanasiou, 2009). Articular cartilage injury can be acute or chronic. Injury of articular cartilage can be categorized into 2 types depending on lesion depth, partial thickness or full thickness (Fig 1). So far, no publication has reported clinical data on the prevalence or incidence of articular cartilage injury. This study determined the prevalence of articular cartilage injury in dogs with various stifle disorders. The results from this study should be useful for future studies on articular cartilage injury in dogs.

Materials and Methods

Animals: In this clinical study we investigated 323 dogs (166 males and 157 females) that was presented

for stifle surgeries at five different small animal hospitals in Chiang Mai from October 2006 to July 2012. The data collected included breed, age, weight and sex of dogs, operation method, articular cartilage injury score, and position of lesion.

Diagnostic procedures in femoral condyles articular injury included evaluation directly after arthrotomy was performed. The classification followed that of the International Cartilage Repair Society (ICRS) (Brittberg and Winalski, 2003), which categorizes the degree of articular injury into four grades. Grade I: superficial lesions, soft indentation and/or superficial fissures and cracks; grade II: lesions extending down to <50% of cartilage depth; grade III: cartilage defects extending down >50% of cartilage depth, as well as down to a calcified layer and down to but not through the subchondral bone (blisters are included in this grade); and grade IV: lesions extending down to subchondral bone exposure. All cartilage evaluation in 323 dogs was performed by one veterinarian.

Statistical analysis: Data regarding sex and breed of dogs, surgical procedure, position of the lesion on the bone, and type of joint injury were analyzed by descriptive analysis. Frequency and percentage were used to assess sample characteristics. Chi-square test was used to analyze the relationship of those factors to the cartilage injury. The weight and age of animals in the cartilage injury and non-cartilage injury groups were analyzed by independent *t*-test. *P*-value= 0.05 was considered significant.

Results

Cartilage injury lesions were diagnosed in 44 out of 323 dogs treated in local orthopedic clinics from October 2006 to July 2012 (Table 1). This number represented 13.6% of the total stifle surgery patients. Surgical operations in this study included repair of anterior cruciate ligament (ACL) rupture (14.2%), distal femur fracture (15.2%), and patellar luxation (66.6%); and removal of intramedullary (IM) pin from the tibia (4%) (Fig 1 and Table 2).

Table 1 Dog breeds in the study group (n= 323)

Breed	Frequency	Percent
Pomeranian	94	29.1
Poodle	53	16.4
Shih Tzu	36	11.1
Native Thai	24	7.4
Yorkshire Terrier	23	7.1
Chihuahua	21	6.5
Miniature Pinscher	14	4.3
Golden Retriever	10	3.1
Labrador Retriever	9	2.8
American Pit Bull Terrier	8	2.5
Pekinase	8	2.5
German Shepherd	6	1.9
Rottweiler	6	1.9
Bangkeaw	3	0.9
Siberian Husky	4	1.2
Bulldog	4	1.2
Total	323	100

Table 2 Number of dogs with various stifle disorders (n= 323)

Disorders	Frequency	Percent
Patellar luxation	215	66.6
Distal femur fracture	49	15.2
ACL rupture	46	14.2
IM pinned tibia	13	4
Total	**323**	**100**

ACL: anterior cruciate ligament, IM: intramedullary

Breed, sex, weight and age of animals and injury: Table 3 shows the frequency of articular injury among individual dog breeds in our patients. Of the 44 dogs in this study, the breeds affected by articular injury were Pomeranian (36.4%), Poodle (25.0%), Native Thai (13.6%), Golden Retriever (6.8%), Shih Tzu (6.8%), Chihuahua (4.5%), Miniature Pinscher (4.5%) and Yorkshire Terrier (2.4%). The ratio of males to females in this study was not significantly different, 51.4% (166 males) to 48.6% (157 females). The weight range of affected dogs (6.19±5.35 kg) and unaffected dogs (8.11±10.71 kg) was significantly different (p= 0.002). The age range of affected dogs (30.59±17.80 months) and unaffected dogs (823.05±17.05 months) did not show a significant difference (p= 0.802).

Articular cartilage injury score and location: This study found grade I cartilage lesion in 26 dogs (59.1%), grade II in 3 dogs (6.8%) and grade IV in 15 dogs (34.1%), while grade III lesions were not found. Lesions on the femoral condyle were found in four different locations: 1 on the lateral condyle (2.27%), 28 on the medial condyle (63.64%), 13 on the trochlear groove (29.55%), and 2 on the transverse plane (4.55%) (Fig 2).

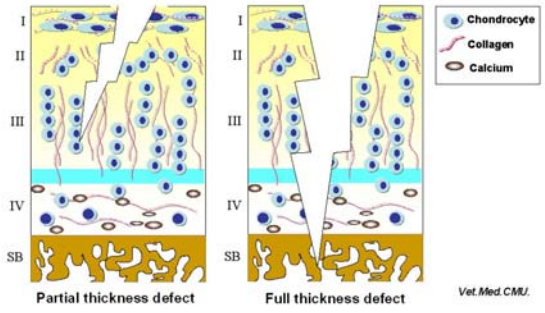

Figure 1 A schematic description of the articular injury is lesions which is not deep into the subchondral bone partial thickness defect. Full thickness defect has lesion deep into subchondral bone (I: superficial layer, II: intermediate layer, III: deep layer, IV: calcified layer, SB: subchondral bone) (drawing by Nganvongpanit, K).

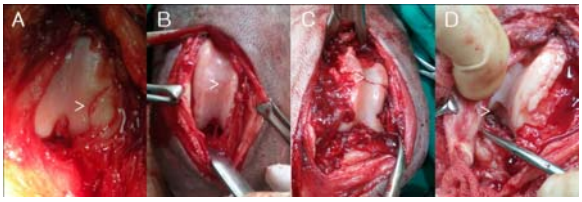

Figure 2 Articular injury (arrow) in dogs with anterior cruciate ligament (ACL) rupture (A), patellar luxation (B), distal femur fracture (C), and IM pin in the tibia (D)

Table 3 Incidence of articular cartilage injury in individual breeds (n= 44)

Breed	ACL rupture	Distal femur	Patellar luxation	Remove tibial	Total
Pomeranian	1	1	10	4	16 (36.4%)
Poodle	0	0	9	2	11 (25.0%)
Native Thai	0	1	1	4	6 (13.6%)
Golden Retriever	0	1	0	2	3 (6.8%)
Shi Tzu	0	0	3	0	3 (6.8%)
Chihuahua	0	0	2	0	2 (4.5%)
Miniature Pinscher	0	0	2	0	2 (4.5%)
Yorkshire Terrier	0	0	1	0	1 (2.4%)
Total	1 (2.4%)	3 (6.8%)	28 (63.6%)	12 (27.2%)	44

ACL: anterior cruciate ligament, IM: intramedullary

Table 4 Number of animals with cartilage injury in different surgical procedures

Cartilage injury	Surgical procedure				Total
	ACL rupture	Distal femur	Patellar luxation	Remove tibial IM	
Yes	1 (2.2%)	3 (6.1%)	28 (13.0%)	12 (92.3%)	44 (13.6%)
No	45 (97.8%)	46 (93.9%)	187 (87.0%)	1 (7.7%)	279 (86.4%)
Total	46	49	215	13	323

ACL: anterior cruciate ligament, IM: intramedullary

Table 5 Incidence of cartilage injury in various stifle disorders of 323 dogs

Cartilage injury	Disorders							
	ACL rupture		Distal femur fracture		Patellar luxation		IM pin tibia	
	Yes	No	Yes	No	Yes	No	Yes	No
Yes	1 (2.17%)	43 (15.52%)	3 (6.12%)	41 (14.96%)	28 (13.02%)	16 (14.81%)	12 (92.31%)	32 (10.32%)
No	45 (97.83%)	234 (84.48%)	46 (93.88%)	233 (85.04%)	187 (86.98%)	92 (85.19%)	1 (7.69%)	278 (89.68%)
Total	**46**	**277**	**49**	**274**	**215**	**108**	**13**	**310**
P-value	0.015		0.097		0.658		<0.001	
Odds ratio	0.124 (0.016–0.901)		0.371 (0.110–1.248)		0.861 (0.444–1.671)		104.250 (13.121–828.300)	

ACL: anterior cruciate ligament, IM: intramedullary

Relationship between articular cartilage injury and diseases: This study found cartilage injury in: 1 dog with ACL rupture (2.17%), 3 dogs with distal femur fracture (6.12%), 28 dogs with patellar luxation (13.02%) and 12 dogs with tibial IM pin to be removed (92.31%). This study significantly found cartilage injury in animals with cartilage injury ($p< 0.001$) presented for IM pin removal from the tibia, with a high odd ratio (104.250) (Table 5).

Discussion

As mentioned in numerous publications, articular cartilage is a major cause of osteoarthritis. Early diagnosis and treatment is very important in order to avoid development of osteoarthritis. Many factors causing articular cartilage damage include age, shear loading, torsional loading, impact, irrigation, intraarticular fracture, and joint surgery (Taskiran et al., 1999; Buckwalter, 2002; Buckwalter and Brown, 2004; Natoli and Athanasiou, 2009).

Few studies are of the prevalence of articular cartilage injury in dogs. This study found articular injury in a lower number of dogs (13.6%) compared with two previous studies. One study (Daems et al., 2009) reported that about two-thirds of 145 dogs undergoing surgery for treatment of patellar luxation had articular injury in the femoral trochlea. In the other study (Hulse et al., 2010), after knee arthroscopy on 63 dogs following correction of ACL rupture using tibial plateau leveling osteotomy, articular injury was found in 39 knees. Five, 7, 9 and 18 knees were grade I, II, III, and IV, respectively. In cases of grades III and IV patellar luxation of our study, lesions were found on 15 medial condyles and 9 lateral condyles, while the other 3 were found at the tibial plateau. In comparison with the study of Daems et al. (2009), which reported articular injury in the femoral trochlea in 33% of 145 dogs undergoing surgery for treatment of patellar luxation, our study found only 13% injury rate (28/187 dogs). There are several possible causes for this difference, including grade of patellar luxation, individual perspectives among veterinarians scoring cartilage lesions, and inclusion criteria of animals. However, such numbers of 33% and 13.02% clearly indicate a high incidence of cartilage injury in patellar luxation patients. Of 28 dogs with cartilage injury from patellar luxation, 22 dogs were grade IV and 6 dogs were grade III. Although the present study did not find a relationship between patellar grade and cartilage grade, articular injury lesions were found to

be related to the side of luxation, 27 dogs with medial patellar luxation had an injury on the medial femoral condyle, while 1 dog with lateral patellar luxation had an injury on the lateral femoral condyle. The in and out movement of the patella on the femoral condyle is a possible cause of cartilage injury. However, to make a conclusive determination, more investigations must be performed on a larger number of dogs with patellar luxation.

A previous study showed that joint instability could lead to articular cartilage injury (Buckwalter and Brown, 2004). Surprisingly, we found that only 1 dog with anterior cruciate ligament rupture (out of a total of 46 dogs) had grade I cartilage injury on the medial condyle. Many studies reported that anterior cruciate ligament rupture is associated with meniscal injury rather than articular cartilage injury (Jackson et al., 2001; Case et al., 2008; Hayes et al., 2010). It is possible that stifle joint instability from rupture of the anterior cruciate ligament has no effect on articular cartilage but a direct effect on the meniscus.

Among patients with distal femur fracture in this study, 6.12% had articular fracture; the other 93.88% had fracture at the distal end, but the fracture line did not run through the articular cartilage. Also, 100% of cartilage injuries in cases of articular fracture were grade IV.

Other etiology of stifle joint articular injury involves complications from intramedullary pinning at the tibia (Dixon et al., 1994; Payne et al., 2005). The present study found articular injury in 92.31% of dogs during IM pin removal from the tibia with the highest odds number (104.250). The lesion was found on the trochlear groove in all cases. The results from this study, together with previous studies (Dixon et al., 1994; Payne et al., 2005), strongly indicate that using intramedullary pinning technique to correct fractures at the tibia should be avoided. Even if the surgical procedure is performed very skillfully, postoperative leg movements can cause dislocation of the pin, which may then penetrate into the joint cavity. This was confirmed by post-surgery radiography.

Other factors, i.e. sex, age, breed and weight of dogs, cannot conclusively be associated with articular injury because the recorded data could not be used for statistical analysis. For example, this study found that Pomeranians (36.4%) and Poodles (25.0%) had the highest incidence of articular injury because those animals had a high prevalence of patellar luxation in Chiang Mai (Nganvongpanit and Yano, 2011). A disadvantage of this study is that cartilage lesions were only investigated in dogs referred for stifle joint surgery; the incidence of cartilage injury may thus not be precisely representative. In fact, in attempting to ascertain the incidence of cartilage injury in dogs, the experimental design should include performing arthroscopy or arthrotomy for every animal showing clinical signs of lameness, and even in some cases that have no obvious clinical signs. But conducting such an experiment would be impossible for many reasons, for example, pet owners may not permit surgery to be performed on healthy dogs, and animal ethics committees may not approve. However, the results of this study provide useful information about the incidence of cartilage injury of the stifle disorders from a variety of causes.

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