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Title

Prevalence, treatment and outcome of patellar luxation in dogs in Italy A retrospective multicentric study (2009–2014)

Authors

Francesca Bosio 1; Antonello Bufalari 2; Bruno Peirone 3; Massimo Petazzoni 4; Aldo Vezzoni 5

Institutions / Vet Clinics

1-Clinica Veterinaria Villa Francesca, Seriate, BG, Italy;

2-University of Perugia, Department of Veterinary Medicine, Perugia, Italy;

3-University of Turin, Department of Animal Pathology, Grugliasco, Turin, Italy;

4-Clinica Veterinaria Milano Sud, Orthopaedics and Traumatology, Peschiera Borromeo, MI, Italy;

5-Clinica Veterinaria Vezzoni, Cremona, Italy

Keywords

Dogs, patellar luxation, prevalence

Summary

Objective: To determine the prevalence of patellar luxation in dogs in Italy and its relation to signalment, the frequency and the type of postoperative complications and the outcome of treatment, and to compare the findings with those of other studies.

Materials and methods: The medical records from four referral clinics were searched for dogs with orthopaedic disorders referred from 2009 to 2014. From these data, the records of dogs with patellar luxation were identified, and the signalment, age and body weight, grade, side and direction of patellar luxation, treatment, postoperative complications, and outcome were retrieved. Univariate and multivariate statistical analyses were used to evaluate the data.

Results: Of 8,694 canine orthopaedic cases, fractures not included, patellar luxation was diagnosed in 559 dogs (801 stifles). Mixed breed dogs were most commonly affected (18%), 85% of the luxations were medial, and 52% of the dogs were female. Of the 559 dogs examined, 400 (574 stifles) met the inclusion criteria for treatment evaluation. Minor complications occurred in five percent of the dogs, and major complications in 16%, including recurrence of patellar luxation in seven percent of the dogs. The outcome was good in 88% of stifles, fair in two percent, and poor in 10%.

Clinical significance: Although patellar luxation was more common in small breed dogs, it also was diagnosed in a significant number of large breed dogs, which included medial patellar luxation in 73% and lateral patellar luxation in 27% of stifles. Body weight and grade of luxation were the only variables statistically correlated with surgical complications.

Introduction

Patellar luxation is one of the most common orthopaedic diseases of the canine stifle. It was ranked the seventh most common orthopaedic condition in small animal practice in Great Britain, and was shown to have a prevalence of 5.4% in dogs in the United States of America (1, 2).

Medial patellar luxation is much more common than lateral luxation (92% compared to 8%) in both small and large breed dogs (3–4). Lateral patellar luxation has been previously associated with large breed dogs, but a recent study by Gibbons and colleagues showed that although the prevalence of patellar luxation in large breed dogs is increasing, lateral patellar luxation is not (5). The frequency of bilateral luxation varies from 50% to 93% of stifles (6). These results support the notion that congenital factors are involved in the occurrence of patellar luxation (7).

Patellar luxation can be classified as congenital, developmental, or traumatic depending on its time of onset. The majority of cases are considered developmental because they occur early in life during skeletal growth and there is no history of trauma. Luxation may not be present at birth, but the anatomical deformities causing luxation often can be detected in puppies (8). Patellar luxation can be treated conservatively or repaired using a variety of surgical techniques, which depend on the age and size of the dog, the grade and degree of chronicity of the luxation, and the presence of underlying limb deformities (9). Surgical techniques include capsulorrhaphy, retinaculum release, rectus femoris transposition, tibial tuberosity transposition, trochleoplasty, patellar groove replacement, and corrective osteotomies of the tibia or femur (10–19).

To the authors' knowledge, the prevalence and treatment of canine patellar luxation have not been determined in Italy. The present retrospective study collected data on patellar luxation from four veterinary referral clinics, which were located in different parts of Italy, to determine the prevalence of canine patellar luxation relative to the orthopaedic case load, the prevalence of patellar luxation in different breeds of dogs, the age at diagnosis, and the relationship with sex and weight of dogs. Additional aims were to determine the direction and degree of luxation, the frequency and severity of complications after conservative or surgical treatment in relation to the degree of luxation, and the risk factors and outcomes associated with different surgical approaches.

Materials and methods

Case selection

Medical records of dogs with patellar luxation referred to two orthopaedic referral centres (Clinic 1: Clinica Veterinaria Vezioni, and Clinic 3: Clinica Veterinaria Milano Sud) and to two university hospitals (Clinic 2: University of Perugia, and Clinic 4: University of Turin) between January 2009 and December 2014 were examined retrospectively. The total number of stifles was recorded for that same time period. An affected stifle joint was defined as a case and dogs with bilateral patellar luxation were considered to be two surgical cases for the purpose of statistical analysis. All dogs that had a follow-up examination a minimum of two months after treatment of patellar luxation, independent of type of treatment, were included in the study. Dogs that had no record of a follow-up examination were included in the epidemiological prevalence study only. The medical records of dogs with patellar luxation were searched for breed, sex, age at diagnosis, body weight, limb affected, direction and grade of luxation, uni- or bilateral

involvement, conservative or surgical treatment(s) and complications. Dogs were divided into three categories based on their weight as defined by Priester: small = less than 9 kg, medium = 9.1 to 18 kg, and large = 18.1 kg and over (20).

Complications

Complications were considered major when a second surgical procedure was required and minor when they could be re-solved conservatively. Recurrence after surgical correction was considered a major complication. The population was divided into two groups (dogs with and without postoperative complications) to determine whether age and body weight had a significant effect on surgical complications.

Outcome

The outcome was considered good when primary surgical treatment resulted in patellar stabilization and complete functional recovery, fair when patellar luxation recurred but was less severe than the original grade of luxation, and poor when patellar luxation recurred and was the same grade or worse.

Statistical analysis

Statistical software was used for all analyses. The 10 most commonly affected breeds were included in a histogram for the epidemiological study. Dogs of other breeds were allocated to three categories according to size. Because the number of stifles for each veterinary centre was different, the percentage of dogs of each breed was used instead of real numbers. A second histogram was created to show the distribution of stifles in relation to the grade of luxation as well as the distribution of medial patellar luxation versus lateral patellar luxation among the four veterinary centres.

To determine the prevalence of medial and lateral patellar luxation in relation to sex, age and body weight, descriptive statistics were used. Chi-squared test, Student's t-test or Fisher's exact test was used to examine the association between categorical variables (sex, age, body weight, grade and direction of luxation, unilateral or bilateral luxation). Logistic regression analysis was used to investigate variables associated with complications, outcome, and recurrence. Kruskal-Wallis test and Mann-Whitney U test were used to analyse differences in surgical techniques and in outcome. Differences were considered significant at $p < 0.05$.

Results

Prevalence

Of 8,694 canine orthopaedic cases seen during the six-year period, there were 801 cases of patellar luxation in 559 dogs resulting in an overall prevalence of patellar luxation of 9.2% (Clinic 1: 10%, Clinic 2: 12%, Clinic 3: 8%, Clinic 4: 5%).

Signalment

Dogs with patellar luxation ranged in age from three months to 15 years (mean age: 31.1 months); 43% were less than one year of age, 30% were one to three years, and 27% were more than three-years-old. Small breeds comprised 47% of the population, medium-sized breeds 22%, and large breeds 31%. The female-to-male ratio was 1:1.1; 48% were male and 52% were female dogs (**Table 1**). Bilateral patellar luxation was diagnosed in 43% of the dogs and unilateral patellar luxation in 57%. Medial patellar luxation was seen in 85% of the stifles and lateral patellar luxation in 15%. The severity of patellar luxation was classified as grade 1 in 110 stifles (14%), grade 2 in 371 stifles

(46%), grade 3 in 214 stifles (27%), and grade 4 in 106 stifles (13%). Grades 2 and 3 patellar luxation predominated in all groups of dogs.

Patellar luxation was diagnosed in 73 breeds of dogs. The most common breeds in descending order were mixed-breed dog (19.6%), Cavalier King Charles Spaniel (7.5%), Miniature Pinscher (6.6%), Chi-huahua (6.2%), Miniature or Toy Poodle (5.4%), Labrador Retriever (4.7%), German Shepherd Dog (3.7%), English Bulldog and Yorkshire Terrier (3.1%), and Boxer (3%). Each of the remaining 63 breeds had a frequency of less than three percent and were included in one of the three groups according to body size (**Figure 1**).

Treatment

Of the 559 dogs (801 stifles) examined, 400 dogs (574 stifles) met the inclusion criteria. Forty dogs (64 stifles) underwent medical management and restricted exercise, and 360 dogs (510 stifles) underwent single session surgical repair of patellar luxation, which was unilateral in 58% and bilateral in 42% of the cases.

Conservative treatment was the most common therapeutic choice for grade 1 patellar luxation (60%). Transposition of the tibial tuberosity, trochleoplasty, or overlapping capsulorrhaphy were the most employed treatment options, alone or in combination, for grade 2 patellar luxation (respectively 52%, 50% and 50%) and for grade 3 patellar luxation (respectively 28%, 32% and 31%).

Corrective osteotomy of the tibia or femur, in combination with either trochleoplasty or patellar groove replacement were used in 38% of grade 3 patellar luxation and in 33% of grade 4 patellar luxation.

Complications

The overall frequency of major complications after surgical correction was 16%. Recurrence of luxation was the most common major complication (7%; 35% of all complications) and had the highest frequency of 11% in grade 3 patellar luxation. There was a significant correlation ($p = 0.01$) between the frequency of major complications and grade of patellar luxation, but not between complication and sex and side of luxation. The highest prevalence of major complications was 24% in grade 3 patellar luxation and 15% in grade 4 patellar luxation. Other major complications were implant failure (2.1%), cranial cruciate ligament rupture (1.2%), improper correction of limb deformities (0.9%), tibial tuberosity avulsion (0.7%), wound dehiscence (0.7%), fracture of the tibia or femur (0.7%), patellar ligament laceration (0.5%), infection (0.5%), non-union of the femur (0.4%), improper soft tissues release (0.4%), lysis of the fracture site (0.4%), and peroneal neurapraxia (0.3%).

There was a five percent frequency of minor complications, which were most common in grade 1 (9%) and grade 4 patellar luxation (8%). Minor complications included infection ($n = 7$), delayed union of corrective distal femoral osteotomy ($n = 4$), delayed functional recovery ($n = 4$), pin migration ($n = 2$), muscle contracture ($n = 2$), and arthrosynovitis ($n = 2$).

The population was divided into two groups. Dogs with complications (147 of 400 dogs, 37%) and without complications (253 dogs, 63%) to determine whether age and body weight significantly affected surgical complications. Body weight was the only variable significantly associated with complications; the body weight of dogs without complications was significantly less than that of dogs with complications ($p = 0.003$). Logistic regression was used to determine the effect of different variables on the outcome of the various surgical procedures. There was no correlation between recurrence and independent predictors (sex, age, body weight and side of luxation) but there was a significant correlation between body weight and the occurrence of complications ($p = 0.0035$). Eighteen different surgical approaches were identified, and each

combination of surgical corrections was evaluated in relation to the grade of luxation. There were no complications in 79% of stifles re-evaluated at a minimum of two months postoperatively. Of the 109 stifles with complications, 83 were major requiring an additional surgical intervention, and 26 were minor and did not require a further operation (**Table 2**).

The most common repair techniques for each grade of patellar luxation and their complications are shown in **Table 3**.

In grade 1, 3 and 4 patellar luxation, there were no differences in the rate of recurrence among the most common types of surgical treatments. In grade 2 patellar luxation, chi-square analysis showed a significant association between recurrence rate and surgical treatment, particularly transposition of the tibial tuberosity only and transposition of the tibial tuberosity with capsulorrhaphy and trochleoplasty ($p = 0.002$).

Outcome

The best surgical results were achieved in grade 1 (92%) and grade 2 (92%) patellar luxation. The frequency of poor outcome was 17% in grade 3 and 12% in grade 4 patellar luxation. The prevalence of fair outcome was inversely proportional to the grade of patellar luxation (**Table 4**).

There were no significant associations between independent predictors (sex, age, body weight and side of luxation) and the outcome scores. To better understand the frequency of good, fair and poor outcome in relation to the surgical technique, the two most commonly used surgical techniques were considered for each grade of patellar luxation (**Table 5**).

In grade 1 patellar luxation, transposition of the tibial tuberosity with capsulorrhaphy resulted in a good outcome in 100% of stifles. In grade 2 patellar luxation, both transposition of the tibial tuberosity combined with trochleoplasty, and transposition of the tibial tuberosity combined with capsulorrhaphy and trochleoplasty, had good outcomes (94% and 97% of stifles). The highest prevalence of poor outcomes occurred in grade 3 patellar luxation that did not undergo a corrective osteotomy; this resulted in a failure of 18% of stifles. In grade 4 patellar luxation treated with corrective osteotomy together with trochleoplasty, recurrence of luxation (9%) was similar to those treated with traditional techniques (transposition of the tibial tuberosity, capsulorrhaphy, and trochleoplasty; 10%).

Discussion

The prevalence of patellar luxation in dogs with orthopaedic disorders in four veterinary practices in Italy was 9.2% during a six year period, which was considerably higher than the prevalence of 5.4% observed in a study from the USA during a 10 year period conducted in 10 veterinary teaching hospitals (2). It is possible that the prevalence of patellar luxation calculated in the present study was inflated due to a different breed distribution between the American and Italian dog owners.

Studies on the relationship between the age of the dog and prevalence of patellar luxation are conflicting. In agreement with the findings from Hayes and colleagues, we reported diagnosis of patellar luxation at an earlier age in large breed dogs compared to medium and small breeds (**Figure 2**) (21). Among our dogs, those less than one year of age formed the largest group, whereas the groups of one to three years and older than three years were of similar size. It is not surprising that patellar luxation manifests relatively early in life in dogs predisposed to this condition. However, another study reported a positive correlation between age and the occurrence of patellar luxation, and that the prevalence of patellar luxation increased 1.1-fold with every additional year (22).

Large-breed dogs weighing a minimum of 18 kg made up 31% of patellar luxation stifles in the present study. Our results differed from those reported in a study by Bound and colleagues in which large-breed dogs (43% of that study population) had a higher prevalence of patellar luxation than dogs of small breeds (3). Even though lateral patellar luxation has always been considered more common in medium and large breeds, a number of studies have found that the prevalence of medial patellar luxation is greater in these breeds (11, 21, 23, 24). In the present study, 75% of dogs with medial patellar luxation belonged to small and medium-sized breeds. This was in agreement with reports of an inverse relationship between body weight and the probability of developing patellar luxation (20, 22). The distribution of lateral patellar luxation was 20% in small breeds, 24% in medium-sized breeds, and 56% in large breeds. Again, our results contrast those of Bound and colleagues, in which only 10% of dogs with lateral patellar luxation were small breeds and 70% were large and giant breeds (3). Our investigation found that in large-breed dogs with patellar luxation, 73% had medial luxation, and 27% had lateral luxation. The prevalence of medial patellar luxation in our study was high at 85% and the prevalence of lateral patellar luxation was low at 15%; however, the latter was higher than the rates reported by Hayes and colleagues (2%) and Bound and colleagues (8%) (3, 21). The majority of cases of lateral patellar luxation in our study occurred in large-breed dogs (67 of 124 stifles), which is in agreement with the findings of others (5, 10, 33). Older studies found that unilateral patellar luxation was more common in dogs, but recent research has shown that the prevalence of bilateral patellar luxation is higher (21, 23-26). By contrast, the frequency of unilateral patellar luxation (57%) was slightly higher than that of bilateral patellar luxation (43%) in the present study.

Mixed-breed dogs and Cavalier King Charles Spaniels (7.5%) had a relatively high prevalence of patellar luxation. Other studies determined that Toy Poodles, Boston Terriers, Chihuahuas, Yorkshire Terriers, and Pomeranians were breeds with the highest predisposition for patellar luxation (21, 27). Hayes and colleagues reported a low prevalence of patellar luxation for mixed-breed dogs (4.8%), whereas our study found that mixed-breed dogs represented 19.6% of the population of orthopaedic patients (21). LaFond and colleagues reported a high prevalence of patellar luxation in Toy Poodles (19.7%), which is in contrast to the results of our study in which this breed comprised only 5.4% of the affected dogs (2). Labrador Retrievers had the highest prevalence of patellar luxation in the study conducted by Bound and colleagues, but were ranked sixth in our study (3). The divergence of these results probably reflects differences in the popularity of dog breeds among countries. Studies investigating the association between sex and patellar luxation in dogs have generated conflicting results; some have reported a higher prevalence in males, while others have shown a higher prevalence in females (5, 20, 21, 24, 28, 30). We found no significant difference in the prevalence of patellar luxation in females and males (1.1:1), which was in agreement with other recent studies (3, 26). We calculated a higher prevalence for grade 2 (46%) and grade 3 (26%) patellar luxation than for grades 1 and 4, which is in agreement with the findings of Hayes and colleagues (23). The low prevalence of grade 1 patellar luxation (13%) may have been a reflection of the caseload of referral centres, where usually the most severe cases are diagnosed. The frequency of complications reported after treatment using traditional repair techniques varies from 18% to 48% (29). The most frequent complications include recurrence of luxation, implant failure, wound dehiscence, arthrosynovitis, pin migration, avulsion fractures, and deficiency of the stifle extensor mechanism (31, 32).

There are no guidelines for selecting the type of surgical procedure that will best reduce the prevalence of recurrence in a given case of patellar luxation. Surgical guidelines are subjective and influenced by the conditions associated with patellar luxation, such as the age and body weight of the dog, direction and chronicity of luxation, and underlying skeletal alterations (9).

Grade 1 patellar luxation is usually treated conservatively when it is not accompanied by clinical signs (5). Of the 40 dogs (68 stifles) treated conservatively in our study, worsening of the grade of patellar luxation was seen in three (4 stifles) at the following check-up. Because they were all younger than one year of age, corrective surgery may have been more beneficial than conservative therapy. Traditional surgical repair techniques usually are chosen in grade 2 and 3 patellar luxation, whereas corrective osteotomies of the distal femur, proximal tibia, or a combination of both may be required in grade 4, but occasionally also in grade 3 patellar luxation (8, 27). Trochleoplasty, overlapping capsulorrhaphy, and transposition of the tibial tuberosity were the most common surgical procedures carried out in dogs with grade 2 and 3 patellar luxation, which is in agreement with the results of another study done in 2014 (6). In contrast to the study of Shaver and colleagues, we used corrective osteotomies not only in dogs with grade 4 patellar luxation but also in those with grade 3 patellar luxation (68 stifles) (34). The highest prevalence of poor outcome was reported in dogs with grade 3 patellar luxation that did not undergo corrective osteotomy. The outcome of grade 3 and 4 patellar luxation could have been influenced by the underlying skeletal abnormalities over surgical technique employed. Unfortunately, the underlying skeletal abnormalities were not included in the available data. Complications occurred in 21% of stifles (109); 16% (83 stifles) were major complications, including recurrence of patellar luxation (7%, 38 stifles) required surgical revision, and five percent (26 stifles) were minor complications. These findings were in general agreement with the results of Clerfond and colleagues (6). Shaver and colleagues reported that the rate of complications after surgical correction of patellar luxation is greater in heavier dogs than in lighter dogs (34). This is in agreement with the results of the present study, which showed a significant difference between the rate of complications in small and large breeds. We found that age was not a risk factor for the development of complications after surgical correction of patellar luxation, which supports the findings of recent studies (4).

There was no significant difference in recurrence or outcome among the most commonly used combinations of surgical techniques for repair of the different grades of patellar luxation except for patellar luxation grade 2, in which treatment was significantly associated with the frequency of complications.

Consistent with other studies, a satisfactory outcome was achieved in 88% of all stifles (n = 449) in the present study and in 92% of stifles with grade 1 (41 out of 45) and 2 patellar luxation (223 out of 242) (29, 30). A good outcome was reported in 100% of stifles with grade 1 patellar luxation treated with transposition of the tibial tuberosity and overlapping capsulorrhaphy, even though minor complications occurred in eight percent of those stifles. In the majority of the 38 cases that had recurrence of patellar luxation after surgical correction, the owners declined a second surgical procedure for financial reasons or because they felt that the clinical signs did not warrant further treatment. Nevertheless, nine owners agreed to a second corrective surgery, and the outcome was good in eight of these cases that were re-evaluated two months postoperatively. The outcome in the other case was fair.

While the data collected from four veterinary referral centres in different areas of the Country with large orthopaedic case-loads may reflect the general prevalence of patellar luxation in Italy, collection of data from numerous veterinary clinics around the country would have given a more precise picture of the epidemiology and prevalence of patellar luxation. It was not possible to determine the underlying skeletal abnormalities in each dog and correlate them with the surgical treatment and outcome. Those data would have provided a better understanding of the prevalence of recurrence of patellar luxation after surgical treatment. Risk factors such as age, sex, body weight and breed would have been determined more precisely by including a control population. In turn, this would have allowed comparison with other case-control studies.

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Author Contributions

AV was responsible for conception and design of the study. FB, AB, BP, and MP were responsible for data acquisition while FB and AV were responsible for data analysis and interpretation. All authors were involved in the drafting and revising of the manuscript and all approved the submitted version.

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Legends of figures and tables

Figure 1

Breed distribution of dogs with patellar luxation seen at four referral centres because of orthopaedic problems (CKCS = Cavalier King Charles Spaniel).

Figure 2

Median age at diagnosis of patellar luxation in large breed dogs compared to medium and small breeds.

Table 1

Distribution of dogs with medial patellar luxation and with lateral patellar luxation according to sex, age and body size.

Table 2

Frequency of postsurgical complications (n = 109 stifles) in dogs in relation to different grades of patellar luxation (n = 510 stifles).

Table 3

Most employed repair techniques used in dogs with different grades of patellar luxation and their frequency of complications. The percentage of treatment performed for each combination of techniques is correlated to the total number of surgeries for each grade

Table 4

Surgical outcome in dogs with different grades of patellar luxation, regardless of the treatment performed in the 510 stifles surgically treated

Table 5

Surgical outcome of the two most employed repair technique(s) amongst all of the different techniques used, performed in different grades of patellar luxation, for 199 dogs

Tables and figures

Figure 1

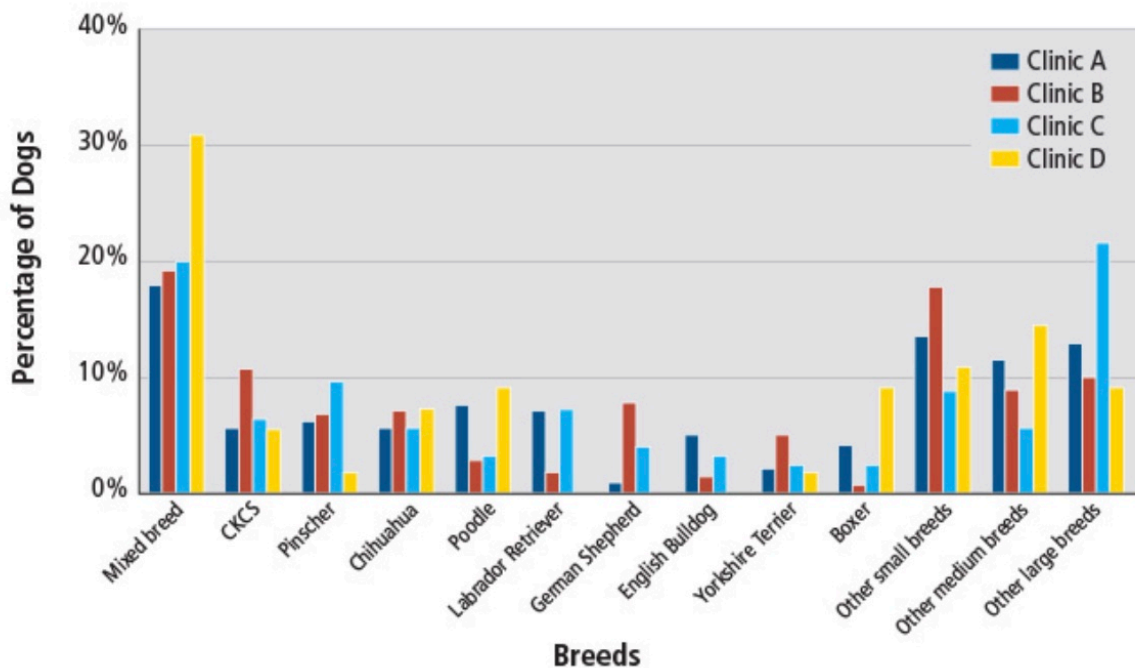


Figure 2

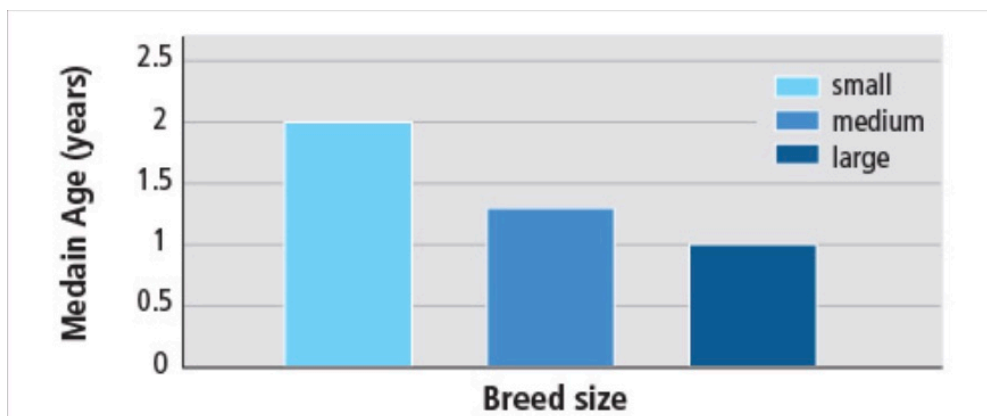


Table 1

	Medial patellar luxation (474 dogs or 85%)			Lateral patellar luxation (85 dogs or 15%)			Total (559 dogs)
	Unilateral	Bilateral	Total	Unilateral	Bilateral	Total	
Female	138 (29%)	118 (25%)	256 (54%)	19 (22%)	18 (21%)	37 (43%)	293 (52%)
Male	133 (28%)	85 (18%)	218 (46%)	27 (32%)	21 (25%)	48 (57%)	266 (48%)
<1 year	94 (20%)	95 (20%)	189 (40%)	27 (32%)	24 (28%)	51 (60%)	240 (43%)
1–3 years	91 (19%)	61 (13%)	152 (32%)	7 (8%)	7 (8%)	14 (16%)	166 (30%)
>3 years	86 (18%)	47 (10%)	133 (28%)	12 (14%)	8 (9%)	20 (23%)	153 (27%)
Small (≤9 Kg)	123 (26%)	123 (26%)	246 (52%)	7 (8%)	10 (12%)	17 (20%)	263 (47%)
Medium (9.1 – 18 Kg)	55 (11%)	46 (10%)	101 (21%)	10 (12%)	10 (12%)	20 (24%)	121 (22%)
Large (≥18.1 Kg)	93 (20%)	34 (7%)	127 (27%)	29 (34%)	19 (22%)	48 (56%)	175 (31%)

Table 2

Complications		Grade 1	Grade 2	Grade 3	Grade 4	Total
Major	Total number	6 (13%)	30 (12%)	36 (24%)	11 (15%)	83 (16%)
	Number with recurrence of patellar luxation	0	16 (7%)	17 (11%)	5 (7%)	38 (7%)
Minor		4 (9%)	10 (4%)	6 (4%)	6 (8%)	26 (5%)
None		35 (78%)	202 (84%)	107 (72%)	57 (77%)	401 (79%)
Total		45	242	149	74	510

Table 3

Grade	Treatment options	% treatments performed	Minor complications	Major complications	
				Total % of major complications	Recurrence of luxation
1	TTT + CAPS	30%	8.3%	0%	0%
	TTT	27.5%	0%	18%	0%
2	TTT + CAPS + TROCH	29.8%	0%	5.8%	4.1%
	TTT + TROCH	17.5%	2.5%	2.5%	2.5%
	TTT + CAPS	12.7%	0%	24%	10%
	CAPS + TROCH	10.1%	8.6%	4.3%	4.3%
	TTT	8.8%	5%	30%	15%
3	TTT + CAPS + TROCH	23.4%	5.8%	14.7%	11.7%
	TTT + CAPS	9%	0%	23%	23%
	TROCH + CO	9%	23%	15.3%	0%
	CAPS + TROCH	8.3%	0%	16%	8.3%
	TTT + TROCH	7.6%	0%	36%	0%
4	TROCH + CO	18.6%	9%	27%	9%
	TTT + CAPS + TROCH	16.9%	20%	10%	10%

TTT = transposition of the tibial tuberosity; CAPS = capsulorrhapy; TROCH = trochleoplasty; CO = corrective osteotomy.

Table 4

Outcome	Grade 1	Grade 2	Grade 3	Grade 4	Total
Good	41 (92%)	223 (92%)	121 (81%)	64 (87%)	449 (88%)
Fair	2 (4%)	5 (2%)	3 (2%)	1 (1%)	11 (2%)
Poor	2 (4%)	14 (6%)	25 (17%)	9 (12%)	50 (10%)
Total	45	242	149	74	510 stifles

Table 5

Outcome	Grade 1		Grade 2		Grade 3		Grade 4	
	TTT	TTT + CAPS	TTT + CAPS + TROCH	TTT + TROCH	TTT + CAPS + TROCH	TROCH + CO	TTT + CAPS + TROCH	TROCH + CO
Good	9 (82%)	12 (100%)	64 (94%)	39 (97%)	28 (82%)	13 (100%)	9 (90%)	8 (73%)
Fair	1 (9%)	0	0	0	0	0	0	2 (18%)
Poor	1 (9%)	0	4 (6%)	1 (3%)	6 (18%)	0	1 (10%)	1 (9%)
Total dogs	11	12	68	40	34	13	10	11

TTT = transposition of the tibial tuberosity; CAPS = capsulorrhaphy; TROCH = trochleoplasty; CO = corrective osteotomy.

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