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Treatment Options for Cranial Cruciate Ligament Rupture In Dog - A Literature Review

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Abstract

Cranial cruciate ligament (CrCL) breaks in dogs can be treated by surgical and non-surgical methods. Choice of the treatment method of cranial cruciate ligament rupture in dog continues to be a real problem for veterinarian clinicians. This topic has been the subject of many studies. Investigation of the speciality literature data concerning the surgical treatment options in the management of cranial cruciate ligament injuries) in dogs, remains, in the conditions of an informational avalanche, a present concern, The purpose of this study was to analyze additional evidence which have appeared in the literature in the period of 2006 - January 2017 and which advocate with concrete evidences in the favour or disfavour of a particular method of dogs' cranial cruciate ligament injuries treatment. Analysis of online searches using PubMed engine in 403 articles suggest that the data analyzed do not allow accurate comparisons between different treatment procedures of cranial cruciate ligament deficiency in dogs and did not show significant differences nor major changes when compared to previous reports (from 1963 to 2005). New long-term clinical studies must be designed and further biomechanical and kinematic analyses are required to determine the optimal technique, and whether these procedures are superior to other stabilization methods.

Keywords: Cranial Cruciate ligament deficiency; Dog; Treatment procedures; Trend

Introduction

Choice of the treatment method of cranial cruciate ligament (CrCL) rupture in dogs continues to be a real problem for veterinarian clinicians. This topic has been, since 1963 [1], the subject of many concerns and studies. CrCL breaks in dogs can be treated by surgical and non-surgical methods. The latest study investigating the speciality literature on surgical treatment options in the management of CrCL ruptures in dogs was published in 2005 [2] after an online bibliographic search through Medline, PubMed, Veterinary Information Network, and Commonwealth Agricultural Bureau Abstracts, with 240 sources being found and analyzed, and it ends with the conclusion „At this time, the application of evidence-based medicine in analyzing the current available evidence suggests that there is not a single surgical procedure that has enough data to recommend that it can consistently return dogs to normal function after CCL injury".

Referring only to the surgical procedures used to treat dogs' CrCL ruptures, a review from 2011 [3] was focused only on extracapsular procedures and shows that there is no data to allow recommendation of a specific technique being necessary „future studies should be directed toward outlining the virtues and inadequacies of the current techniques" and another study investigating the literature (444 paper works) with constant referring only on surgical procedures occurred in 2014 [4] conclude that tibial plateau levelling osteotomy (TPLO) is superior to the extra capsular lateral side suturing procedures, but there are insufficient data to properly assess other surgical methods. There are also several studies comparing the effectiveness of surgical and non-surgical therapeutic methods, the latest being dated in 2013 [5-7]. The purpose of this study was to analyze additional proof which have appeared lately in the speciality literature in the favour / disfavor of a particular method of CrCL breaks treatment in dog.

Materials and Methods

In January 2017, an online search was conducted, using three search engines: Google scholar (https://scholar.google.ro), PubMed - US National Library of Medicine National Institutes of Health (https://www.ncbi.nlm.nih.gov/pubmed) and Taylor & Francis Online (http://www.tandfonline.com). There have been used as basic search term "cranial cruciate ligament rupture in dog" preceded into three main additional insights by the terms „treatment", nonsurgical treatment", surgery treatment", last with

the following secondary insights „lateral extracapsular stabilization treatment", "tibial plateau levelling osteotomy - TPLO", "tibial tuberosity advancement - TTA", "triple tibial osteotomy - TTO" and "Maquet". Filtering of the results was done using „most recent" and „best match" for PubMed engine, „article" for Google scholar and subject" and publication date" for Taylor & Francis Online. The results obtained by investigating PubMed were analyzed and classified according to the method proposed by Aragon and Budsberg, 2005 [2], after the evaluation method used:

a) Force plate analysis,

b) Subjective and objective evaluation by the clinician and 3 - subjective evaluation by the pet owner, being considered relevant in this order (1 - maximum and 3 - minimum).

Table 1: Number of scientific papers identified online.

	Search Engines		
Descriptors	**Google scholar (https://scholar.google.ro)**	**PubMed – US National Library of Medicine National Institutes of Health (https://www.ncbi.nlm.nih.gov/pubmed)**	**Taylor & Francis Online (http://www.tandfonline.com)**
cranial cruciate ligament rupture in dog	10.600	403	62
treatment cranial cruciate ligament rupture in dog	9550	267	51
surgery treatment cranial cruciate ligament rupture in dog	8530	251	41
lateral extracapsular stabilization treatment in cranial cruciate ligament rupture in dog	735	5	2
tplo treatment in cranial cruciate ligament rupture in dog	983	33	4
tta treatment in cranial cruciate ligament rupture in dog	465	21	1
tto treatment in cranial cruciate ligament rupture in dog	384	3	1
tightrope in cranial cruciate ligament rupture in dog	140	4	0
maquet procedure in cranial cruciate ligament rupture in dog	162	3	0
bone anchor in cranial cruciate ligament rupture in dog	1340	3	20
nonsurgical treatment in cranial cruciate ligament rupture in dog	1120	3	1

Results and Discussion

Results of the bibliographic online introspection are shown in Table 1. The analysis of search results with PubMed engine reveals 403 articles (for the period 1963 - January 2017), respectively 391 after manual excluding of those in whose abstract no connection to CrCL was found. In the period 2006 - January 2017, 216 articles were found regarding CrCL in dog, data that reveals a near doubling of number of articles reviewed by Aragon and Budsberg until August 2004 [2]. Instead, between 2006 and January 2017, only 115 articles have appeared regarding therapeutic results evaluation of dogs' CrCL ruptures from which only 23 were relevant articles of level 1, according to the criterion (evaluation by force plate analysis), 86 articles of level 2 (subjective and objective evaluation by the clinician) and 6 articles of level 3 (subjective evaluation by the pet owner).

Of the 23 articles of level 1, six articles promotes kinematics and force plate analysis methods for the diagnosis of dogs' CrCL ruptures [8-13]; articles describe or compare the results obtained with different techniques of surgical treatment [14-24]; Nelson et al. [11]; Mols et al. [25-27] and two articles describe and compare the results obtained with different nonsurgical treatment techniques versus surgical [28]; Wuchereria et al. [7].

If in 2005 there is the opinion that a correct assessment of effectiveness of dogs' CrCL rupture treatment method only the investigations of level 1 can be considered as reliable [2,29], reaffirmed subsequently [8,14] there are some studies appeared quite recently [25] which conclude that ground reaction forces may be inadequate as a sole method for assessing functional outcome after cranial cruciate ligament repair". Articles of level 2, for the most part, make the inventory of postoperative complications of different treatment types [30-43] or show mixed results of level 2 with 3 [44-46]. The estimated costs of surgical treatment for cranial cruciate ligament ruptures in dogs in USA in 2003 were 1.32 billion dollars [47]. Surgical techniques for the repair of cranial cruciate ligament deficiency can be classified into three categories: intra-articular grafts, extracapsular suture stabilization and proximal tibial osteotomy (Hulton, 2013

Intra-Articular Stabilization Techniques: Includes, Use autografts, allografts, xenografts, and synthetic materials to replace the affected CrCL Paatsama et al. [48-61] makes the inventory of the main reasons of intra-articular procedures low use: - auto grafts have inferior stiffness and strength compared with normal ligament; - allografts have the inconvenience of collection and storage; - synthetic materials caused intra-articular fibrosis, bone abrasion and chronic inflammatory response; which has limited their use in veterinary medicine.

Extra-Articular Stabilization Techniques: Includes Lateral fabellar suture (LFS), percutaneous placement of the lateral fabellar suture (pLFS), Tightrope (TR) [62], transcondylar toggle system [63], modified lateral extra-capsular technique with bone anchor. The treatment using lateral flabella suture (LFS) remains at this moment the most practiced method, applied particularly in small dogs. The major shortcoming of the method (overloading of suture anchor points) [64] has benefited from the contribution of several studies [65-68] which introduced the concept of anchoring in isometric position (relatively isometric) but also the anchor through bone anchors [69-79]. Efforts to identify the ideal material for suture when lateral fabellar suture is applied were materialized by the dethronement of nylon wires as the main option [74-79] and by promoting polyethylene wires which are stronger, stiffer and elongate less than nylon leader [60,71,80] promising options offers the poly blend wires [81] and braided polyester [69].

Securing of the suture reveals the existence of three systems: a square knot (SQ), a slip knot (SL) and a crimp clamp (CR). Existing data show no new information being maintained the recommendation [82] "that 27-kgt nylon leader line be secured with a SL, and 27-kgt nylon fishing line be secured with a SQ" as the "clamping the first throw of a square knot in monofilament nylon leader material who increases failure load by two percent and stiffness by 16%, and decreases elongation by 12%" [74] although there are studies showing that "crimping suture alters the biomechanical properties of the loop" [80]. Securing the suture through CR remains a superior method of knotting techniques [83,84] and the wave pattern crimp system is more efficient then the single crimp system [85]. Using tensioning sutures systems before applying a crimp clamp does not bring significant advantages over manual tightening [86].

Difficulties in various procedures' execution are reported to be the bone tunnels creation in TR and anchoring around the fabella in LSF and pLSF [87]. Evaluation of extra capsular therapeutic methods efficiency, although it is the subject of several studies [74,86,88]; Anderson et al. [83]; [89,90]; Guenego et al. [70]; [62,63,70]; Havig et al. [16,17] with mostly positive reports, show that many of these studies are subjective (level 2 and 3). Studies based on analysis of data obtained through force plate measurements show that peak vertical force was 93% and vertical impulse was 96% of normal values in the limbs of dogs that had extra-articular stabilization at six months following surgery [90], recorded differences being insignificant when compared to normal preoperative values in all studies which appeared before 2006 [88,89] and after [16,17]. Postoperative complications reported after the application of extra-articular stabilization techniques are between 4.2 and 17.4% [91]; Frey et al. [33] and a 7.2% of them required reintervention [91].

Proximal Tibial Osteotomy Techniques: Includes, tibial plateau levelling osteotomy-TPLO, combined tibial plateau levelling osteotomy and tibial tuberosity transposition (TPLO-TTT), tibial tuberosity advancement-TTA with the variants TTA-1, TTA-2 and TTA-rapid, triple tibial osteotomy -TTO and modified Maquet procedure-MMP. All procedures impart primarily change the biomechanics of the stifle and required specialized and custom equipments. The choice of source of this equipment depend on surgeons' preferences or/and their affiliation to certain product companies [92]. Recent assessments of the effectiveness of therapeutic methods of tibial osteotomy reveals unanimously that locomotor function of the limb with CrCL insufficiency can be improved using the techniques of tibial osteotomy [93]; Dymond et al. [31,17]; Christopher et al. [44]; described so far Slocum and Devine [94-100].

More prospective and retrospective studies [101-104]; Bruce et al. [93]; Haaland & Sjöström [34]; Lafavere et al. [105] ; Stein et al. [45]; Voss et al. [18]; Duerr et al. [106]; Proot & Cooke [39]; Moles et al. [43]; Dymond et al. [31,33]; Conkling et al. [107] ; Imholt et al. [36]; Taylor et al. [40,41]; Gatineau et al. [108,109]; Steinberg et al. [46]; Etchepareborde [110]; Hishenson et al. [35]; Rotherford et al. [37, 42, 44]; Etchepareborde [111]; Butterworth and Kydd [30] report one or more complications (osteomyelitis, incisional infections, fractures of the tibia or fibula, broken drill bits, hemorrhage, intra-articular implant displacement, intra-osteotomy screw displacement, retained surgical sponges, broken holding pins or screws, septic arthritis, loose implants, draining tracts, ring sequestrum, incisional inflammation, dehiscence and swelling, oedema and seroma formation, bruising, premature staple removal, patellar tendon swelling, and late meniscal injury) after proximal tibial osteotomy procedures.

In TPLO postoperative complication rates, until 2006, ranged between 45.7 and 28% [102,104,107]; compared to 22.2-8.4% after 2006 Duerr et al. [106]; Frey et al. [33,36]; Conkling et al. [107,109] and 4.8% of the cases requiring implant removal [41]. In TTA, the method introduced in practice in 2002 [103], showed postoperative complication rates between 35.5% and 11% [105]; Voss et al. [18]; Dymond et al. [31], with 5.2% reinterventions [42]. In TTO, postoperative complication rate was between 18% and 23% [43]. For MMP, two complications were documented (subsequent meniscal injury) from a series of 12 cases and 10.8% postoperative complications with 3.1% reintervention in a series of 65 cases [93]. Comparative analysis of the obtained data (2006-2007) which assess the therapeutic efficiency by force plate measurements or kinematic data between extra-articular stabilization methods and tibial osteotomy methods [17,11,25,27] as well as between different methods of tibial osteotomy [26] does not show significant differences between methods and no major changes when compared to previous reports.

Non-Surgical Treatment Methods: Includes, administration of non-steroidal anti-inflammatory drugs, weight control, restriction of spontaneous locomotion, physiotherapy including hydrotherapy Baker and Bake; Comerford et al. [6,7]. These methods are usually applicable to small dogs with a body weight below 15 kgs [6]. In the treatment of obese dogs with ruptured CrCL, surgical methods had a success rate (was defined as an affected limb net ground reaction force > 85% of the value for healthy dogs and a ≥ 10% improvement of the initial values) at 52 weeks after surgery of 75% compared to 63.6% in those treated by non-surgical methods [7]. The data presented are similar to those of previous studies, based only on clinical examination and with a success rate of 85.7% reported for small dogs with body weight below 15 kgs (Vasseur). Latest data concerning non-surgical methods of treatment (Baker and Bake, 2013; Comerford et al., 2013 [6,7] and veterinarians options for these therapeutic modalities [5] did not show a change in trend compared to previous reports [112], the majority of doctors preferring surgical approaches [113-116].

Conclusion

Currently available data does not allow accurate comparisons between different treatment procedures of cruciate cranial deficiency in dogs. New long-term clinical studies must design and further biomechanical and kinematic analyses are required to determine the optimal technique, and whether these procedures are superior to other stabilization methods.

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