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Assessment of Extractions of Deciduous Mandibular Canine Teeth to Correct Linguoversion Malocclusion in 17 Dogs

Kirk Herrmann, DVM[1], and Kendall Taney, DVM, DAVDC, FAVD[1]

Abstract

A search of medical records at the Center for Veterinary Dentistry and Oral Surgery, Gaithersburg, MD was conducted to identify patients who received extractions of deciduous mandibular canine teeth to treat linguoversion. Patients were included if they were less than 5.5 months of age and had a diagnosis of deciduous class 2 or bilateral class 1 malocclusions. Treatment was considered a success if normocclusion of the permanent dentition was achieved at follow up evaluation. Seventeen patients represented 13 different breeds. No significant correlation was seen between age of treatment (mean age 3.34 months) or sex (11 males, 6 females). Six patients had class 1 malocclusions (35.29%) and eleven patients had class 2 malocclusion (64.71%). Of the six dogs treated for class 1 malocclusions, two had traumatic palatal contact and four had only minor soft tissue contact. Eleven cases of class 2 malocclusion were treated and of these there was one mild, six moderate, and four severe cases of mandibular distocclusion. All cases treated for class 1 malocclusions had a successful outcome resulting in permanent normocclusion (100%), while class 2 malocclusions had success in three of eleven cases (27.27%). The outcomes based on occlusion type were determined to be significant ($p = 0.009$). All participants had immediate relief of soft tissue trauma and no significant side effects of treatment were recorded. The results show that extractions of deciduous linguoverted mandibular canine teeth (LMC) can immediately improve traumatic impingement and may be a factor in providing a comfortable and functional adult occlusion. Further investigation with a larger sample size would be warranted.

Keywords

linguoverted mandibular canine, malocclusion, interceptive orthodontics, deciduous canine teeth

Introduction

Linguoversion of the mandibular canine teeth and mandibular distocclusion are common conditions noted in adolescent veterinary patients. Soft tissue impingement of deciduous mandibular canines on the palatal mucosa can cause discomfort (Figure 1) and when left untreated can lead to negative sequelae such as oronasal fistulae, bleeding, traumatic dental fractures, attrition and alteration of normal dentofacial development.[1–3] It is postulated that even when the potential trauma is not severe, the barrier created by the inappropriate relationship between the occlusal arcades can cause a physical barrier to growth and limit further potential for mandibular lengthening.[1–5]

Colloquially known as *base narrow canines*, the common treatment option has historically been extraction of the deciduous mandibular canines in an effort to improve the outcome of the final occlusion. This proactive method of orthodontic treatment is termed *interceptive orthodontics*.[1–3,5] Defined in human literature as prompt intervention addressing unfavorable features of the developing occlusion that may allow achievement of a satisfactory result.[6] In our veterinary patients *interceptive orthodontics* aims to alleviate adverse dental interlock through selective extraction of any deciduous dentition that have the potential to cause a physical barrier to maturation.

Linguoverted mandibular canine teeth (LMC) in adult dentition requires management through use of orthodontic appliances, crown reduction with vital pulp therapy or surgical extraction. These methods require multiple anesthetic events or permanent alteration of the adult dentition. By intervening prior to the eruption of the permanent teeth through interceptive methods, the goal of obtaining normal adult occlusion or reducing the severity of the malocclusion can potentially be achieved.

The surgical extraction of deciduous mandibular canine teeth is a frequently performed procedure by primary veterinary practitioners and veterinary dentists alike. In the hands of an experienced veterinary oral surgeon this procedure can be done with minimal expense, limited resources and with a fast

[1]Center for Veterinary Dentistry, Gaithersburg, MD, USA

Corresponding Author:
Kirk Herrmann, Center for Veterinary Dentistry, 518 WHITE SURF TER, Gaithersburg, MD, 208782939, USA.
Email: herrmannkirk@gmail.com

Figure 1. Bilateral deep ulcerations in the palatal mucosa adjacent to the canine teeth, due to untreated class 2 malocclusion in a 6-month-old German shepherd dog.

recovery time for the patient. Although this procedure is done with great frequency, the potential final outcome shows variable success. The aim of this study was to evaluate the likelihood of normalization of the permanent occlusion following extractions of the deciduous mandibular canines in patients with LMC.

Materials and Methods

Medical records of dogs who received exodontic treatment of mandibular canine teeth for deciduous malocclusions at the Center for Veterinary Dentistry and Oral Surgery, Gaithersburg, Maryland over a period of approximately 6 years (November 2012 to March 2019) were identified and further evaluated. Patients were included in the study if they were less than 5.5 months of age, diagnosed with class 1 or class 2 malocclusion with bilateral linguoversion of mandibular canine teeth, photographic evidence of deciduous malocclusion was available and follow up evaluation of the adult occlusion was present. Dogs were excluded from the study if they had unilateral malocclusion or if follow up evidence of the adult occlusion could not be obtained.

Patient information was gathered from medical records on initial presentation including pertinent medical history, signalment, physical exam findings and photographic evidence of the presenting malocclusion. Follow up examination notes or photographic evidence of permanent occlusion were evaluated after eruption of adult dentition to determine the outcome of the procedure. The classification of malocclusion was based on the interdigitation of the maxillary and mandibular dentition with a focus on the relationship between the deciduous mandibular canine tooth and the interproximal space between the third maxillary incisor and maxillary canine teeth, termed the "canine triad interlock".[1,7] Class 1 malocclusions were classified as those having a normal rostro-caudal relationship of the maxillary and mandibular dental arcades with bilateral linguoversion of the deciduous mandibular canine teeth; whereas class 2 malocclusions showed a disproportionate skeletal relationship causing distal positioning of the mandibular canine teeth. Further subgroups were categorized based on severity of the malocclusion. Class 1 malocclusions were divided into more severe cases where linguoversion was causing palatal contact and those which were not. Class 2 malocclusions were categorized based on the relationship of the maxillary and mandibular canine teeth to help classify the severity of mandibular distoclusion. Mild cases were considered to be those where greater than or equal to 50% of the crown of the mandibular canine tooth was mesial to the occlusal maxillary canine tooth from the lateral perspective; moderate cases were considered those where the mandibular and maxillary canine teeth were in the same plane when viewed from a lateral position; and severe cases were those where greater than or equal to 50% of the mandibular canine tooth was distal to the opposing maxillary canine tooth when viewed from a lateral position. In cases where there was discrepancy between sides, the patient was categorized based on the more severely affected side.

Patients included in the study underwent bilateral surgical extractions of deciduous mandibular canine teeth in order to alleviate soft tissue trauma and to reduce the mechanical obstruction. Dogs were pre-medicated with a singular intramuscular injection of hydromorphone[a] (0.1 mg/kg) or morphine[b] (1 mg/kg) (based on drug availability) and an IV catheter was placed in the right cephalic vein. Patients were induced with intravascular midazolam[c] (0.4 mg/kg) followed by propofol[d] to effect and standard endotracheal intubation was performed. Patients were placed in dorsal recumbency, put on mechanical ventilation and maintained on 1–2% isoflurane gas[e] in oxygen at 1.5L/min. Intravascular ampicillin[f] (22 mg/kg) and subcutaneous carprofen[g] (4 mg/kg) were administered following induction. Heart rate, blood pressure, ECG, blood oxygenation, end tidal CO2 and temperature were monitored throughout the procedure. A balanced electrolyte solution[h] was administered intravenously at 10 ml/kg/hr and temperature support was provided by a water-circulating heating pad[i] below and an electric heating pad above, separated from the patient's body with thick towels.

Pre-operative dental radiographs of the deciduous mandibular canines were obtained to evaluate root structure and the underlying permanent tooth bud. Local anesthetic blocks of the middle mental nerves were performed using 0.5 mls per site of a 1:3 2% lidocaine[j] and 0.5% bupivicaine[k] mixture. A single mucoperiosteal incision was made over the palpable deciduous tooth root, the flap was elevated both in the mesial and distal directions to allow access to the root for alveolar bone removal. Following judicious buccal alveolar bone removal deciduous mandibular canines were luxated and extracted.[3,8] Complete extraction was confirmed via dental radiographs and the mucoperiosteal flaps

were closed using 4-0 chromic gut suture[l] material in a simple interrupted pattern (Figure 2). Patients were sent home with 12.5–16 mg/kg amoxicillin-clavulanic acid[m] PO q12h for 10 days, 3.5–4 mg/kg carprofen[n] PO q24h for 7 days and 3–5 mg/kg tramadol[o] PO q12h for 7 days. Instructions were given to feed a soft diet and to avoid aggressive chewing and hard toys for 14 days. Ball therapy was advised during eruption of the permanent dentition. An informative discussion regarding ball therapy technique was explained to owners and recommendations were made to allow for at least three 15-minute sessions per day until complete eruption of permanent teeth could be appreciated.[9] A follow up examination was recommended fourteen days post-operatively and again at the time of eruption of the permanent canines. The procedure was considered a success if there was a normal occlusal relationship in the "canine triad" and no soft tissue trauma was appreciated. A case was considered a failure if soft tissue trauma was still evident or if the relationship between the canine dentition was not considered ideal. Some cases showed a functional occlusion with an inappropriate interdigitation of the mandibular canine tooth in the diastema of the maxillary canine and first premolar teeth. In this study these cases were not considered successful as the intended outcome was for an ideal occlusion which provides optimal mastication.

Statistical analysis of success rates based on age, sex and extent of deciduous malocclusion were performed using a Fisher's test. A p-value below 0.05 was considered statistically significant.

Results

Initial search results of medical records for patients with bilateral deciduous canine extractions for treatment of LMC resulted in 23 cases. Retrospective interpretation showed that six cases did not report for follow up evaluation. Five of those cases could not be reached due to change of contact information or failure to respond to contact efforts, one patient was deceased. Therefore, the final group of patients included in the study was 17 individuals where extractions of deciduous mandibular canine teeth were performed as a treatment of LMC and the following calculations are based on those patients.

The 17 patients represented 13 different breeds with Labradors, standard poodles and Havanese being represented by two individuals each. Of the seventeen patients, fifteen were purebred dogs. All patients were intact at the time of the procedure. There were 11 males and 6 females with a mean age of 3.34 months (2-5.4 m). No significant correlation with outcome was seen concerning both age of treatment or sex. Proportions of malocclusions and severity are represented in Table 1. Six patients had class 1 malocclusion (35.29%) and eleven patients had class 2 malocclusion (64.71%). Of the six dogs treated for class 1 malocclusions, two had palatal contact of their canine teeth at presentation and the remaining four only had soft tissue contact within the diastema. Eleven cases of class 2 malocclusion were treated with one mild, six moderate and four being severe.

Figure 2. Final closure following surgical extraction of the deciduous canine tooth using 4-0 chromic gut in a simple interrupted suture pattern. The coronal aspect of the closure was left open to allow for unimpeded eruption of the permanent successor.

Six out of six (100%) of the cases treated for class 1 malocclusions had a successful outcome resulting in permanent normocclusion, while class 2 malocclusions had success in three out of eleven cases (27.27%) (Figures 3A and 3B). The outcomes based on occlusion type were determined to be significant ($p = 0.009$). All three cases of severe mandibular distocclusion that underwent extractions of deciduous mandibular canines were considered failures (Figures 3C and 3 D) (Table 2). No gross abnormalities of the adult dentition following deciduous extractions were recorded during follow-up or photographic evaluation.

Discussion

Linguoversion of the mandibular canine teeth is one of the most commonly seen malocclusions in veterinary medicine.[9] Malocclusions can be inherited or acquired via systemic or local influences. Acquired malocclusions are further categorized as pre-natal (congenital) or post-natal (developmental). Systemic causes include endocrine imbalances, nutritional deficiencies, toxins or infectious agents. Local influences that disturb the orofacial complex include trauma and inappropriate exfoliation of deciduous dentition.[1]

Craniofacial growth and skeletal malocclusion are not monogenic in nature, instead they are influenced by a combination of genetic factors. Human studies have supported this concept by following growing pairs of monozygotic (share an identical genotype) and dizygotic twins. The outcome of their observations showed that 100% of monozygotic twins with class 2 (division 2) malocclusions shared the abnormality whereas 90% of dizygotic twin pairs had discordant occlusions, showing an individual's genetic makeup has a strong influence over the phenotype.[10] Such suggestive cohort studies have not been investigated in the canine model, but through historic test breeding of dogs with varying skull types it has long been determined that there is an inherited component to craniofacial

Table 1. Type of Malocclusion and Treatment Result in the Study Group.

Breed	Age at Treatment (months)	Diagnosis	Success (S) / Fail(F)
Portuguese Water Dog	3	MAL1, diastema	S
German Shepherd	4	MAL1, diastema	S
Soft Coated Wheaton	2.4	MAL1, diastema	S
Goldendoodle	2.3	MAL1, diastema	S
Standard Poodle	4	MAL1, palatal	S
Standard Poodle	3.3	MAL1, palatal	S
Miniature Schnauzer	5.4	MAL2, mild	S
Rottweiler	4	MAL2, moderate	S
Labradoodle	4	MAL2, moderate	S
Havanese	2	MAL2, moderate	F
Labrador	3	MAL2, moderate	F
Siberian Husky	3.4	MAL2, moderate	F
German Shepherd	4	MAL2, moderate	F
Newfoundland	2.6	MAL2, severe	F
Havanese	3	MAL2, severe	F
Rhodesian Ridgeback	3	MAL2, severe	F
Labrador	3.3	MAL2, severe	F

structure and a genetic independence between the growth of the maxilla, mandibles and size of dentition.[4,11]

Nasomaxillary and mandibular growth differ in their method of expansion. The maxilla pushes forward through a passive response to growth of the cranial base and active appositional growth at the sutures. In contrast, the mandible grows through endochondral replacement of the cartilaginous covering of the mandibular condyle with posterior growth and anterior bony resorption of the ramus.[4,12] This growth pattern directs the rostral mandible in a forward direction through condylar growth and periosteal apposition of the caudal ramus with very little length coming from the rostral segment.[12] Few current studies on regulation of craniofacial growth in the dog exist with most veterinary orthodontic information being drawn from human literature and historic canine studies.

The unique deep interdigitation of the canine occlusion and the significance of these occlusal forces during development make other traditional mammalian models such as humans, rodents and pigs insufficient in speculating the true nature of jaw growth in canines. Unlike humans, the deep interdigitation of the canine interlock and its associated occlusal forces appears to have an important role in development. In one study, the occlusal forces on the right mandible of a dog were interfered with by extraction of the deciduous teeth. The result was unilateral shortening of the height and length of the ramus, a less developed condyle, and a lateral deviation of the maxilla to the right; presumably due to a shortening of the right maxilla.[13] Similarly, in another dog, the elimination of the occlusal forces by extracting the left maxillary deciduous teeth, resulted in lateral deviation of the left maxilla associated with a shortening of the left side.[13]

Further anecdotal evidence that inappropriate interlock may cause impedance to normal mandibular growth comes from reports of young dogs undergoing palatal surgery. The results were an irregular interlock due to surgical manipulation of the maxilla. In such cases normal mandibular growth was impeded and the jaw tended to bow ventrally in response to the irregular interlock, showing that a disturbance between the normal appropriate relationship of the opposing dentition can cause permanent modification to the craniofacial complex. In the current study, by extracting the deciduous teeth interfering with normal occlusal forces, the principles of these previously outlined studies were taken into account with a focus on alleviating the adverse interlock.

Corrective treatment options for LMC of permanent dentition typically involve active or passive orthodontic appliances (inclined plane, crown extensions, expansion screws and W-springs), gingivoplasty, crown reductions with vital pulp therapy or surgical extraction of the adult dentition.[14–17] In the author's clinical setting the most common treatment options for adult LMC, based on severity and individual circumstances, are palatal inclined planes or crown reduction with vital pulp therapy. A palatal inclined plane is a passive orthodontic appliance that serves as a sliding board to tip the mandibular canine teeth into their desired position by relying on the intermittent forces of the muscles of mastication for orthodontic movement.[9,14–17] Tipping is the most common movement in veterinary orthodontics and refers to movement of the coronal portion of the tooth where the crown moves in opposite direction to the root. Lighter forces for coronal tipping are encouraged as this moves the fulcrum more apically and carries a better chance for success.[1,9,14,16,17] Inclined planes can be either fabricated during the anesthetic procedure using acrylic/composite or made as cast metal appliances prior to installation. Orthodontic appliances are reserved for adult malocclusion and require multiple anesthetic events with adequate owner compliance. Potential complications associated with this treatment option include mucosal irritation and impedance of normal maxillary growth due to the fixation of the device. This concern can be alleviated by using two separate appliances or incorporating a telescoping device. A limitation of this treatment option is that it requires an appropriate relationship between maxillary and mandibular jaw length to garner success, limiting its usefulness in treating class 2 malocclusions of any severity.

Figure 3. Photographs of two patients before and after interceptive orthodontics. A) A 2.4-month-old dog with a class 1 malocclusion showing soft tissue contact within the diastema. B) Patient from Figure 3A at 1 year of age showing successful treatment and normal occlusion. C) A 4-month-old German shepherd dog with a moderate class 2 malocclusion showing marked mandibular brachygnathism and palatal contact. D) Patient from Figure 3C at 10 months of age showing failed treatment with the palatal position of the mandibular canine tooth in relation to the maxillary canine tooth and a persistent discrepancy in jaw length.

If corrective orthodontics is not elected, crown reduction to improve patient comfort can be performed. Extraction of the mandibular canine teeth should be avoided if possible due to inherent weakening of the rostral mandible and possibility of iatrogenic fracture.[8] Coronal reduction procedures with vital pulp capping is an orthodontic treatment with the goal of reducing soft tissue trauma associated with mandibular canines contacting palatal mucosa. This procedure as a treatment for malocclusions has previously been reported to have a success rate of 100%, although in the author's experience this success rate is clinician dependent due to the technique-driven nature of the procedure and inherent large size of the pulp chamber in young patients.[18] Additional retrospective studies have shown less successful outcomes depending on treatment-related variables.[19] This treatment is aimed at reducing traumatic complications and will not return complete functionality to the patient. Due to the physical barrier to eruption caused by palatal contact, care must be taken to reduce the canine teeth judiciously to allow for further eruption in young patients. This procedure remains a good treatment option for severe class 2 malocclusions. Semiannual follow up anesthetic procedures are recommended to assess tooth vitality and to monitor restorations.

Successful interceptive orthodontic procedures differ from those previously mentioned as they require minimal long term follow up care, are typically cost effective, and there is a potential for normocclusion to be achieved in one anesthetic event. Treatment of deciduous malocclusions through selective extractions provides both a relief to traumatic impedance and removes the irregular mechanical interlock allowing for mandibular and maxillary jaws to reach their full growth potential. Initial extractions are usually well tolerated although the ultimate success of the treatment of the adult occlusion can be multifactorial.

Table 2. The Outcome of Treatment Based on Severity of Malocclusion.

Severity of malocclusion	Success/ Failure	Percent Achieving Normocclusion
MAL1, diastema	4/4	100%
MAL1, palatal	2/2	100%
MAL2, mild	1/1	100%
MAL2, moderate	2/6	33.3%
MAL2, severe	0/4	0%

The goal of any orthodontic procedure in veterinary medicine is to provide a comfortable, functional and stable occlusion. A cautious ethical approach to altering a patient's dentition must be taken in order to not propagate the abnormality. In the current study, owners were made aware that it is a generally shared principle among veterinary dentists that malocclusions can be familial in nature. Orthodontic alterations to intact animals, strictly for esthetics, is a difficult concept for most clinicians to consider.

Risks associated with multiple anesthetic events and concerns for further breeding following alleviation of the abnormality should be considered. Patients undergoing any orthodontic treatment should be removed from the breeding population and breeders should be advised not to repeat this combination.

This study included cases of deciduous LMC with varying severities that spanned from mild class 1 malocclusions to severe mandibular distocclusion. Due to that variability, the degree of success of these procedures must be interpreted on an individual basis. The results of this study showed a 100% success rate in treating class 1 malocclusions and a 27.27% success rate in treating class 2 malocclusions of varying severities. This difference was statistically significant and is an expected outcome due to the necessity for bone growth to achieve the intended goal in skeletal malocclusions. This correlates with the understanding that skeletal malocclusions are thought to be inherited and in spite of relieving the inappropriate mechanical interlock, the potential for jaw growth remained stunted due to governing genetic and environmental factors.[4,10]

Three of the eleven total cases of class 2 malocclusions treated showed an ideal adult occlusion on follow up examination. Of the eleven cases, all three of the cases of severe mandibular distocclusion remained abnormal at follow up examination. One mild case and two moderate cases of class 2 malocclusion showed normocclusion on follow up exam. Without a control group of similar patients that did not undergo extractions, it cannot be determined whether these individuals would have resolved without intervention. A retrospective cohort study comparing children treated with interceptive methods during periods of mixed dentition with those who did not, showed that the control group had no improvement or had worsening of their condition in comparison with the treated children who showed a significant improvement in the categories of esthetics, crowding, crossbite and overbite.[6]

Even in cases where normocclusion likely could not be established, it should be considered that by extracting the deciduous canines the irregular occlusal forces can be alleviated which in turn prevents further exacerbation of irregular growth as seen in canine palatal studies. Human studies have shown that even in most situations where interceptive therapy does not produce ideal orthodontic results, it will reduce the severity of the permanent occlusion and can result in an easier second phase of treatment.[6]

Orthodontic intervention at home has been described as a management option of uncomplicated LMC using a removable orthodontic device, termed "ball therapy", to promote lateral tipping. This technique involves stimulating the dog to play using an appropriately sized, round to ovoid toy that fits between the mandibular canine teeth. The force applied by the downward pressure of the dog's own play promotes lateral movement to the misplaced canine teeth and can result in orthodontic correction without anesthetic intervention. It is advised that this treatment be performed for 15 minutes at least 3 times daily, although no minimum play time is known.[9] Information regarding any home therapy following extractions was not available for the present study, therefore pairing *interceptive orthodontics* and a removable orthodontic device during permanent eruption was not investigated. When the ball therapy technique was compared in cases of already erupted teeth versus those which were actively erupting, the success of therapy was higher and rate of correction was faster in younger patients undergoing eruption.[9] Given this information it would be valuable to see if the paired efforts of *interceptive orthodontics* and removable orthodontic appliances could show an even greater success rate of establishing ideal permanent occlusion. Additional investigation would be required to identify a relationship and was out of the scope of the current study.

Surgical extraction of deciduous canine teeth requires special consideration in order to allow for complete removal of the slender roots and to avoid damage to the developing successor. An appropriate analgesia regimen should be chosen and administered for any surgical extractions. Although the variability in efficacy of rostral local analgesia with the mental nerve block is understood, this block is the authors' preference due to multiple cases of inferior alveolar nerve blocks causing lingual desensitization within a clinical setting.[20] In cases of relative atraumatic extractions in young healthy dogs, a multimodal approach using NSAIDs, opioids and middle mental nerve blocks are adequate in our experience

Exodontic procedures are routine in experienced hands but are not without potential complications. Complications include transection of the middle mental nerve, hemorrhage secondary to laceration of the middle mental blood vessels, root tip fractures and collateral damage to neighboring or developing dentition.[8] Although not seen in the current study, enamel pitting, discoloration of the permanent teeth or complete relocation of the developing canine tooth bud have been reported.[3] A single incision was implemented in the above cases to reduce tissue trauma and as it is the surgeon's preference. A pedicle flap with mesial and distal vertical releasing incisions is also an acceptable technique which can allow for better exposure during extractions.

The goal of this study was to evaluate the end result of *interceptive orthodontics* on the adult occlusion, but the success in providing immediate patient comfort is also of importance. Of the 17 cases evaluated, 9 cases (52.9%) of deciduous LMC treated with *interceptive orthodontics* resulted in ideal adult occlusion. Despite varying degrees of severity within this population, all patients treated had immediate relief of the soft tissue trauma following extractions. Regardless of the potential for correction of the malocclusion given the individual and clinical severity, it should strongly be considered as an important stepwise treatment in orthodontic planning.

Due to the retrospective nature of this study, follow up evaluations of the patients proved to be challenging. Most patients were seen only as puppies and many were lost to follow up. It is unknown if this was due to the successful nature of the procedure or the outcome was perceived to be functional and did not warrant further treatment. The cases that most frequently presented for follow up to our practice were those that failed and required additional orthodontic treatment. These difficulties help to explain the limited sample size and potentially skewed rate of failure which may have played a factor in the overall significance of certain conclusions.

The results show that extractions of deciduous LMC can immediately improve traumatic impingement and may be a factor in providing a comfortable and functional adult occlusion. Orthodontic treatments in dogs should have the goal of providing a functional and stable occlusion by altering the position or presence of dentition.[1] *Interceptive orthodontics* should be considered in patients with deciduous LMC to help alleviate soft tissue trauma and to allow the adult occlusion to reach its full potential. Further research with a larger sample size and more reliable follow up are warranted to better correlate treatment with outcome.

Materials

a. West-Ward Pharmaceuticals Corp, Eatontown, New Jersey.
b. Duramorph; West-Ward Pharmaceuticals Corp, Eatontown, New Jersey.
c. Akorn Inc, Lake Forest, Illinois.
d. Actavis Pharmaceuticals Inc, Parsippany, New Jersey.
e. Fluriso; MWI, Boise, Idaho.
f. AuroMedics Phamaceuticals LLC, East Windsor, New Jersey.
g. Rimadyl; Zoetis Inc, Kalamazoo, Michigan.
h. Lactated Ringers Solution; Hospira Inc, Lake Forest, Illinois.
i. T/Pump; Stryker Corp, Kalazamoo, Michigan.
j. MWI, Boise, Idaho.
k. AuroMedics Phamaceuticals LLC, East Windsor, New Jersey.
l. Ethicon, Somerville, New Jersey.
m. Clavacillin; Dechra Veterinary Products, Overland Park, Kansas.
n. Putney Inc, Portland, Maine.
o. Amneal Pharmaceuticals of NY, Hauppauge, New York.

Declaration of Conflicting Interests

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ORCID iD


Kirk Herrmann https://orcid.org/0000-0001-7671-2926

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