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Short Communication

Preliminary evaluation of a hydrogel liquid bandage in 30 dogs undergoing tibial plateau levelling osteotomy surgery

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Abstract

AIMS: To compare the prevalence of minor incisional complications in canine patients undergoing tibial plateau levelling osteotomy (TPLO) surgery that had a hydrogel liquid bandage (HLB) applied to their incision, with patients that had a light adhesive bandage applied.

METHODS: Thirty dogs undergoing TPLO surgery were randomly assigned to either application of a light adhesive bandage to the incision, with removal 18–24 hours later, or application of a clear-drying polyethylene glycol HLB to the incision. Erythema, swelling, discharge, and dehiscence were assessed 1 day (Day 1) and 10–14 days (Days 10–14) postoperatively. All persons completing the assessment were blinded to the treatment. Outcomes were compared for the two groups using Fisher's Exact Test.

RESULTS: On both Day 1 and Days 10–14, the distribution of dogs with erthemyma or swelling did not differ between the two groups ($p \geq 0.4$). The prevalence of erythema was the same in the bandage and HLB groups at Day 1 (11/15; 73%) and was similar at Days 10–14 (3/11 (27%) and 2/11 (18%), respectively). Prevalence of swelling was also the same in the two groups on Day 1 (11/15; 73%) and was similar at Days 10–14 (3/11 (27%) and 6/11 (55%), respectively). On Day 1, 2/15 (13%) dogs in the HLB group and none of the dogs in the bandage group had incisional discharge ($p=0.483$). No dogs were observed with discharge on Days 10–14. No dehiscence, infection, or any other major incisional complication was observed in either group at any point in the study.

CONCLUSIONS: Preliminary results suggest that prevalence of minor incisional complications after TPLO surgery treated with HLB or with a traditional adhesive bandage may be comparable. No major adverse effects were seen with the use of HLB.

CLINICIAL RELEVANCE: Due to several disadvantages of traditional bandaging, which can require post-operative maintenance and removal, lasts only a short time, and be painful when removed, an alternative with fewer drawbacks is desirable. HLB may present such an alternative.

KEY WORDS: ***Tibial plateau levelling osteotomy, incisional complications, hydrogel liquid bandage***

Introduction

Incisional complications such as inflammation and infection are an important source of postoperative morbidity in veterinary patients (Berzon 1979; Coletti *et al.* 2014). For a variety of reasons, including normal animal behaviour and typical post-operative housing, veterinary surgical incisions are easily contaminated postoperatively, increasing the risk of incisional complications (Eugster *et al.* 2004). Wound protection to reduce contamination and thus reduce these complications is desirable. A light topical adhesive bandage is frequently applied to surgical wounds postoperatively for protection. In the authors' experience, bandages have several disadvantages as they require removal or replacement after 18–24 hours, and removal can be painful or stressful. A better alternative is desirable.

Polyethylene glycol hydrogels are used to seal and protect surgical wounds in human patients (Osbun *et al.* 2012; Masket *et al.* 2014) and multiple published *in vivo* human studies have established hydrogel liquid bandages (HLB) to be safe and effective, for example, as replacements for suture to prevent leakage after cataract surgery, and for sealing the dura mater in spinal surgery (Osbun *et al.* 2012; Masket *et al.* 2014; Sarfare *et al.* 2015).

Hydrogel liquid bandages provide several advantages over traditional bandaging, which can be costly, technically difficult, time consuming, and painful or stressful to the patient. HLB can be applied quickly and easily, directly over suture material, and hydrolyse in 7–10 days, eliminating the need for removal (Anonymous 1995; Wallin *et al.* 2005). They also can be applied to areas of the body that are difficult to bandage and, as a liquid, can conform to the architecture of tissue (Maddula *et al.* 2010). Unlike traditional bandages, HLB allow oxygen to

HLB	Hydrogel liquid bandage
TPLO	Tibial plateau levelling osteotomy

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permeate and may prevent wound dehydration (Anumolu *et al.* 2011). Finally, HLB are transparent, allowing continuous monitoring of the incision.

To the authors' knowledge, there are no clinical trials in dogs assessing HLB as an alternative to traditional bandaging in protecting incisions. In the current study, tibial plateau levelling osteotomy (TPLO) was chosen to compare HLB to bandaging for several reasons. It is commonly performed, and the prevalence of minor incisional complications associated with the procedure has been previously published. Additionally, the procedure requires a similar time under anaesthesia for all patients and the location and length of the skin incision are similar, thus eliminating many potential confounding variables that may influence the prevalence of minor incisional complications.

The TPLO procedure was first described in 1993 and, numerous studies have reported the outcome and complications of the procedure (Slocum and Slocum 1993; Pacchiana *et al.* 2003; Gatineau *et al.* 2011). Most complications associated with TPLO have been reported to be minor, including seroma, inflammation, bruising, swelling, premature suture removal, and skin trauma caused by licking (Coletti *et al.* 2014, Garnett *et al.* 2014). One study found minor complications including bruising, swelling, and/or seroma formation in 9.2% of TPLO surgeries (Christopher *et al.* 2013).

Our aim was to provide preliminary data comparing the prevalence of incisional complications following TPLO surgery treated with HLB and treated with a light adhesive bandage for 18–24 hours postoperatively.

Materials and methods

A blinded randomised controlled clinical trial was conducted on 30 consecutive client-owned dogs undergoing TPLO surgery for repair of cranial cruciate ligament rupture between May and October 2014. Written consent was obtained from the owners of the dogs undergoing surgery at the time of admission. The TPLO surgeries were performed by different surgeons, but all skin incisions were closed with an intradermal pattern. Patients were randomly assigned to one of two groups in an alternating fashion: the first group (n=15) had HLB applied to their skin incisions immediately postoperatively, as described below. The second group (n=15) had the incision site bandaged with a light adhesive bandage immediately after surgery, while under sterile conditions. The bandage consisted of a sterile non-adherent pad (Curad, Medline Industries, Mundelein, IL, USA), and an adhesive, cut-to-length dressing retention sheet (Hypafix, BSN Medical GmbH, Hamburg, Germany). The bandage was removed 18–24 hours later.

For the HLB, one syringe containing 0.1 mL of dry polymer SutureSeal (Medicus Biosciences, Santa Monica, CA, USA) was mixed with one syringe containing 1 mL of diluent for 10–15 seconds. This activated the polymer and the resulting liquid was brushed onto each TPLO incision while the patient was still draped under sterile conditions. The liquid forms a gel within 80–120 seconds, resulting in a thin, adherent, flexible, protective coating over the incision.

All dogs were discharged from the hospital with an Elizabethan collar to prevent licking of their incisions.

Assessment of complications

Incisions were evaluated at two time points: at the time of release from the hospital 1 day after surgery (Day 1), and again between Days 10 and 14. An assessment form was used to evaluate four criteria: erythema, categorised as 0, <0.6, 0.6 up to 1.3, 1.3 up to 1.9, 1.9 up to 2.5 or ≥2.5 cm away from the incision; approximate radius of swelling, categorised as 0, <0.6, 0.6 up to 1.3, 1.3 up to 1.9, 1.9 up to 2.5 or ≥2.5 cm away from the incision; presence or absence of discharge from the incision, and presence or absence of dehiscence. Any other major or minor complications were also noted.

Light protective bandages were removed by a veterinary nurse from the critical care department prior to release of the dog from the hospital. A nurse from the surgery department completed assessment forms on Day 1 and on Days 10–14. The bandages were not evaluated for discharge, as the individual removing the bandage was not the same as the individual completing the assessment. HLB is transparent, so after removal of the bandage there was no evidence of which treatment had been applied. As such, all individuals completing the assessment form were blinded to the treatment. For patients where nurses added additional comments to the assessment form, authors additionally evaluated corresponding medical records, to assess the importance of these findings.

Statistical analysis

Data were analysed using STATA Statistical Software, version 11.2 (StataCorp. 2009. Stata Statistical Software: Release 11. College Station, TX, USA). The two groups were compared for erythema, swelling, discharge and dehiscence at each time point (Day 1 and Days 10–14). Exact measurements for small and large values for erythema and swelling were not noted, so these variables were categorised as either 0, ≤2 or >2 cm. A Fisher's Exact test was performed (two-sided in the case of drainage and dehiscence) to examine associations between dressing type and the presence of incisional complications.

Results

All 30 incisions were evaluated for erythema, swelling, discharge and dehiscence on Day 1. Eight patients (four from the HLB group and four from the bandage group) were lost to follow-up and were not evaluated at Days 10–14. The Fisher's Exact test indicated that, on both Day 1 and Days 10–14, the distribution of dogs with different categories of erythema or swelling did not differ between the two groups (Table 1). The prevalence of erythema was the same in the bandage and HLB groups at Day 1 (11/15 (73%) in both groups) and was very similar at Days 10–14 (3/11 (27%) and 2/11 (18%), respectively). Prevalence of swelling was also the same in the two groups on Day 1 (11/15; 73%) and was similar at Days 10–14 (3/11 (27%) and 6/11 (55%), respectively). On Day 1, 2/15 (13%) dogs in the HLB group and none of the dogs in the bandage group had incisional discharge (p=0.483). No dogs were observed with discharge on Days 10–14, or with dehiscence on either Day of evaluation (Table 1).

In this study, there was one possible reported seroma in the HLB group, at Days 10–14. As expected, a majority of all cases (18/30, 60%) had indication of inflammation at Day 1, as noted by the presence of both erythema and swelling to at least some degree,

Table 1. Proportion (%) of dogs that were observed with erythema, swelling, discharge, and dehiscence 1 and 10–14 days following tibial plateau levelling osteotomy surgery that had their surgical incisions dressed with either a hydrogel liquid bandage (HLB) or a light adhesive bandage (Bandage).

Variable	Day 1			Days 10–14		
	HLB	Bandage	P-value [a]	HLB	Bandage	P-value [a]
Erythema (cm)			0.839			1.000
0	4/15 (27)	4/15 (27)		9/11 (82)	8/11 (73)	
≤2	9/15 (60)	7/15 (47)		2/11 (18)	3/11 (27)	
>2	2/15 (13)	4/15 (27)		0/11 (0)	0/11 (0)	
Swelling (cm)			0.858			0.392
0	4/15 (27)	4/15 (26.7)		5/11 (46)	8/11 (73)	
≤2	7/15 (47)	7/15 (46.7)		5/11 (46)	3/11 (27)	
>2	4/15 (27)	4/15 (26.7)		1/11 (9)	0/11 (0)	
Discharge [b]	2/15 (13)	0/15 (0)	0.483	0/11 (0)	0/11 (0)	NA
Dehiscence [c]	0/15 (0)	0/15 (0)	NA	0/11 (0)	0/11 (0)	NA

[a] Significance of Fisher's Exact test comparing the two groups
[b] Proportion in which discharge was observed
[c] Proportion in which wound dehiscence was observed
NA=Not applicable

whereas only 4/30 (13%) cases had evidence of inflammation by Day 10–14, as indicated by the presence of both erythema and swelling. There were no reported cases of other major complications for either group during the investigated time period.

Discussion

In this small-scale clinical trial, no differences in incisional complications were demonstrated between the dogs that were bandaged and those having HBL applied after surgery. The distribution of measured variables between the two groups was very similar, suggesting minor incisional complications were comparable. Moreover, no major adverse events were noted in either group during the investigated time period. These findings confirmed that there was no association between incisional complications and application of HLB compared with the use of a light bandage. Our data set was too small to demonstrate equivalence between the two treatments, as this would require a very large-scale non-inferiority trial. However it does provide preliminary support of equivalence between the groups, and demonstrates that additional, larger scale studies are worth pursuing.

In a study of canine TPLO surgery, there were 47/1,519 (3.1%) reported cases of incisional problems including seroma formation, inflammation, bruising, premature suture removal, and excessive skin trauma caused by licking (Coletti *et al.* 2014). Another study found minor complications including bruising, swelling, and/or seroma occurred following 9.2% of TPLO surgeries (Christopher *et al.* 2013). It is difficult to compare the overall prevalence of incisional complications in our study with others, as those studies did not specifically investigate the same subcategories of incisional complications or note the exact time point at which these observations were made. Nevertheless, the prevalence of complications in both the HLB and the traditional bandage groups were similar to those reported previously.

Two incisions in the HLB group had a small amount of discharge on Day 1 postoperatively. It is possible that HLB provides less protection from contamination than a traditional bandage, contributing to postoperative tissue irritation and resulting discharge. Another possibility is that discharge in the bandage group was present but not noted as the bandage previously in place may have absorbed any recent discharge prior to removal.

The small size of this study limits the conclusion that can be drawn. As the first study evaluating HLB in canine patients, it was intended to be preliminary; as such our study design included a relatively small patient population. As a result, it is difficult to evaluate less common incisional complications such as dehiscence or infection, which did not occur in any patients during the trial.

In addition, to obtain our data, an assessment form was completed by veterinary technicians. Despite training, there is some degree of variability between observers and subjectivity of interpretation of criteria such as redness and swelling. An additional confounding factor is that TPLO surgeries were performed by multiple surgeons. Furthermore our evaluation of swelling was recorded in a single dimension, as radius from the incision, to represent total swelling. As swelling can occur in multiple dimensions, differences in this respect may have been overlooked.

Finally, HLB remains in the wound for approximately 7–10 days before degrading, while the adhesive bandage remained in place for only 18–24 hours. As the incisions of the dogs in the HLB group were protected for longer than the incisions of the bandaged group, this could have led to a greater prevalence of complications in the bandaged group compared to the HLB group.

Despite these limitations, it is reasonable to conclude that preliminary data suggest HLB may prove a viable alternative to adhesive bandages in protecting surgical incisions, as use of HLB does not appear to significantly raise the prevalence of minor incisional complications after TPLO surgery. If further investigation demonstrates equivalence more conclusively, HLB may indeed present a superior alternative to adhesive bandaging.

There are several future directions of study that could prove fruitful. With this preliminary data, a larger non-inferiority trial could bolster evidence that HLB is a reasonable alternative to traditional bandages in protecting surgical wounds. It would also be interesting to investigate the use of HLB in other common surgeries, such

as ovariohysterectomy and orchiectomy, to see if it can potentially reduce incisional complications in these procedures.

In conclusion, we found no difference in minor incisional complications associated with application or maintenance of HLB in TPLO surgery. No major adverse effects were seen with the use of HLB. Further investigation is warranted.

Declaration of interest

Medicus Bioscience provided SutureSeal HLB but was not involved in experimental design or data interpretation.

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