Veterinary Integrative Sciences 2018; 16(3): 247-269

Vet Integr Sci

Veterinary Integrative Sciences

ISSN; 2629-9968 (online)

Website; www.vet.cmu.ac.th/cmvj

Research article

Incidence of post-operative infection and the factors associated with surgical outcomes in 25 dogs and 13 cats with open fracture

Areerath Akatvipat[1,*] and Luddawon Somrup[2]

[1]Department of Companion Animals and Wildlife Clinic, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50100 Thailand

[2]Small Animal Teaching Hospital, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50200 Thailand

Abstract

The objectives of this study were to identify the incidence of postoperative infection and to find the factors that related to the surgical outcome in dogs and cats with open fractures. Twenty-five dogs and 13 cats were diagnosed with open fracture and were underwent orthopedic surgery. The study was prospectively assessed at the Small Animal Veterinary Teaching Hospital, Chiang Mai University, Thailand during May to November 2016. The data of age, sex, body condition score, breed, etiology of open fracture, affected bone, location of fracture, open fracture classification (Grade I, II, III), housing, surgery techniques, duration of accident until surgery, duration after surgery until patient can weight baring on the affected limb were reviewed. Out of 35 patients (62.8%), there were 17 dogs and five cats successfully treating without major complications. The post-operative infection had diagnosed in eight patients (22.86%). Three cats with grade III open fracture had positive Feline leukemia virus (FeLV), sudden leukopenia and were died postoperatively. Using IM pin and its combination in open fractured dogs had 15 times risk of unsuccessful result than using external skeleton fixation technique ($p<0.03$). Cat with body condition score (BCS) three from five had 24 times risk of unsuccessful result than cat with underweight (2/5 BCS) ($p<0.04$). In conclusion, application IM pin and its combination are not recommended in all open fracture cases. Cats with underweight (2/5 BCS) had higher success than the ideal one (3/5 BCS). Due to the poor outcome of FeLV, the feline viral infection screening test must be performed in all cats.

Keywords: Cats, Dogs, Open fracture, Postoperative infection, Surgical outcome

***Corresponding author:** Areerath Akatvipat, Department of Companion Animals and Wildlife Clinics, Faculty of Veterinary Medicine, Chiang Mai University, Muang, Chiang Mai 50100 Thailand Tel (+66) 910760807 E-mail: areerath22@gmail.com

Article history; *received manuscript: 11 May 2018, revised manuscript: 14 June 2018, accepted manuscript: 21 August 2018, published online: 12 September 2018*
Academic editor: *Korakot Nganvongpanit*

INTRODUCTION

An open fracture is the fracture associated with the break of the skin allowing the fractured bone contacted to the microbial in the environment and later leading to bone infection (Halawi & Morwood, 2015; Perry & Bruce, 2015). Moreover, multi-organ injuries can occur associated with bone fracture leading to high risk of morbidity and mortality. Hence, the proper treatment of open bone fracture remains challenging for veterinarians (Perry, 2016). The golden period for surgical debridement of open fracture is within 6 hours after trauma, however, this issue is still being a controversial issue (Fernandes et al., 2015). In practice, open fracture in dogs and cats are often the result of high energy trauma such as road accidents, bite injuries, gunshot wound which leads the patients having impairment of respiratory and/or cardiovascular function (Millard, 2014). Thus, the patient conditions are required to be observed closely. Life-threatening problems must be the first management (Perry & Bruce, 2015). There are several factors of delayed treatment such as delayed transfer of patients from site of the accident to the hospital, delayed of owner declaration, and the available of the operating room and orthopedic surgeon (Halawi, 2015; Perry, 2016). The incidence of open fracture in small animals was previously reported in United States. The study has indicated that the incidence in dogs was 0.09% (95% CI, 0.07% to 0.11%) and 0.12% (95% CI, 0.09% to 0.17%) in cats (Millard & Weng, 2014). Moreover, the study has also showed the incidence of open fracture of tarsal region, scapula, radius or ulna and tibia or fibula were higher risks compared to the fracture of femur (Millard & Weng, 2014). The fracture fixation techniques that were reported in this study, were divided into three groups including plate and screw, external skeletal fixation (ESF), and intramedullary pin (IM pin) and its combinations. The IM pin and its combination were consisting of rush pin, IM pin, crossed pin, tension band wire, and tie-in. There was no reported of using plate-rod and interlocking nail techniques in the study. The aims of this study were to find the incidence of postoperative infection and the factors associated with the surgical outcomes in the dogs and cats with open fracture.

MATERIALS and METHODS

Animals & ethics

All dogs and cats who had open fracture and underwent orthopedic surgery according to the service protocol of the Small Animal Veterinary Teaching Hospital (VTH), Chiang Mai University (CMU), Thailand during May to November 2016 were prospectively assessed. The sample size was calculated by using WinEpi statistical program (95% confidence interval and a margin of error 5 %). There were 25 dogs and 13 cats included in the study and the consent form was signed by the owner. This study was approved by the animal care and use committee of the faculty of Veterinary Medicine, Chiang Mai University under protocol number R7/2559.

Data collection

The patient and treatment data (age, sex, body condition score, breed, etiology of open fracture, affected bone, site of fracture, fracture classification (Grade I, II, III) according to Gustilo and Anderson (1976), housing, surgery techniques, duration of accident until surgery, duration after orthopedic surgery until patient can weight baring on the affected limb) were recorded. The samples were collected during orthopedic surgery before closing the operation wound. Aerobic bacterial identification and the drug sensitivity test were performed. Multimodal pain management were strictly administered in all patients. Opioids (morphine or fentanyl) were used in each case during the operation. Routine intravenous antibiotics either Amoxicillin and clavulanic acid (Cavumox; Siam Pharmaceutical Co, Ltd) or cefazolin were administrated within 6 hours after the patients presenting at the hospital. Orthopedic surgeries were performed with experience surgeons. At least one of experience orthopedic surgeon confirmed the presenting of postoperative complications by the clinical signs and the radiography of the fracture site. Due to the bone mineral content in the callus segment was significantly strong and could be evaluation by radiographic examination at 60 days after the surgery in most animals (Utvag, Korsnes, Rindal, & Reikeras, 2001), thus the cut point of successfully outcome as the patient had lameness score less than 2/4 at the 9th week after surgery.

Data analysis

Data were presented in tables of frequency distribution for discrete variables and using of the average and the standard deviation for continuous variables. Student t- test was used to test two variables between infection and non-infection patients; firstly, the mean of duration from fracture onset until orthopedic surgery, and secondly, the mean of duration from orthopedic surgery until the day that the patient had lameness score less than score 2 after the surgery. Associations between variables the strength of associations between the risk factors and the outcome were analyzed using logistic regression analyses (odds ratio and the 95% confident interval) using R statistical software version 3.5.0. The value of $p \leq 0.05$ was adopted as the significance level.

RESULTS

During six-month period of the data collection, there were 25 dogs and 13 cats with open fracture underwent orthopedic surgery at the VTH, CMU, Thailand (Table 1). Unexpectedly, three cats with grade III opened fracture were diagnosed with feline leukopenia using feline leukemia viral (FeLV) test (Snap combo test, IDEXX Laboratories) and were later died within the first week after orthopedic surgery. However, the routine blood works before surgery of those three cats were not indicated immune deficiency status. Thus, 25 dogs and 10 cats with open fracture were remained to evaluate the occurring of complications after the orthopedic surgery. Out of 35 patients (62.86%), there were 22 patients (17 dogs and 5 cats) had a success result without major complications. The most common complications were infection (8/35, 22.86%). Other complications included delayed union (2/35, 5.71%), implant failure (2/35, 5.71%), non-union (1/35, 2.86%), malalignment (1/35, 2.86%). Howev-

er, some patients had more than one complication postoperatively. The outdoor dogs and cats had higher risk of open fracture which commonly caused by car accident. In dogs, the incidence of open fracture was higher in mature age than the other. Moreover, the incidence of open fracture in male dogs was higher than female dogs. The open fractured bone in dogs, femur (9/25, 36%) was the most likely found, followed by radius and ulna (6/25, 24%), tibia (4/25, 16%), humerus (4/25, 16%), and hock joint (2/25, 8%), respectively. In cats, the incidence of open fracture was similarly between mature and young cats. The open fracture in female cat was higher than in male cats. The number of ideal BCS cats with open fracture were higher than the underweight cats. The common fractured bone that found in cats were femur (4/13, 30.77%), and tibia (4/13, 30.77%). There were also found open fractured bone at hock joint, elbow joint in cats. Some cats had open fractured bone at more than 1 segment. The characteristic of the patient and the outcome of open fracture treatment are shown in Table 1. The etiology of fracture in each grade I, II, III of open fracture is shown in Figure 1. Concerning with complications (n = 8), there were one patient of grade I (12.5%), five patients of grade II (62.5%) and two patients of grade III (25%). There were 14 wound samples from 13 patients that had positive bacteria growth, however, only two patients (2/8, 25%) with postoperative infection had positive bacterial growth from the wound sample which collected during the orthopedic surgery. The presenting of major postoperative complications and the presenting of bacteria from surgical wound during the orthopedic surgery in each open fracture grade was shown in Figure 2.

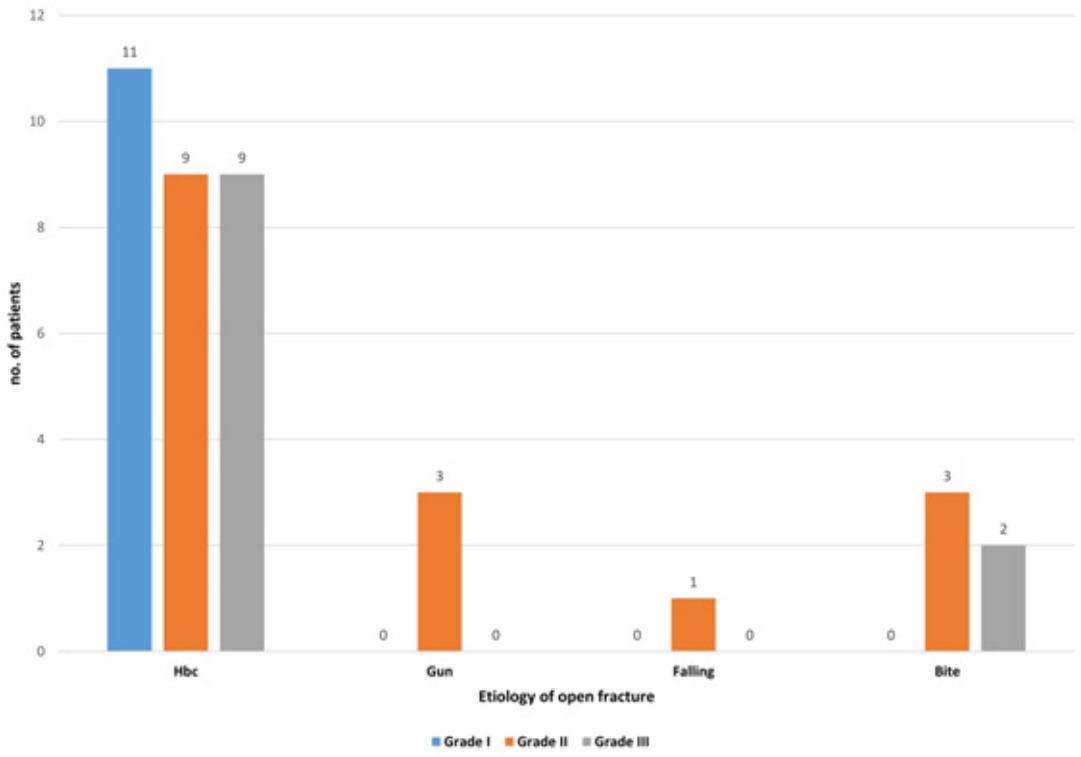

Figure 1 The detail of fracture etiology in each open fracture grade (n=38); Hbc = car accident Gun=gunshot injuries, Falling = falling from a height, Bite = bite injuries.

The factors that influenced to treatment succession; succession define as the animal had lameness score less than 2/4 at 9th week after the surgery and without infection in dogs and cats as shown in Table 2 and 3 respectively. Of 38 patients with open fracture, there were thirty- one cases (31/38, 81.58%) had successfully outcomes and seven cases (7/38, 18.42%) had non-successfully outcomes. Of 31 successfully cases, there were twenty cases (20/38, 52.63%) had good outcomes without any postoperative complications and eleven cases (11/38, 28.95%) with postoperative complications. Of 7 non-successfully outcome,

Table 1 Characteristics of open fractured patients (25 dogs and 13 cats) in this study.

Characteristics	Categories	Number of Dog (n=25)	Number of Cat (n=13)
Age	Pediatric (<1m)	2 (8%)	1 (7.69%)
	Young (1 m to 1 y)	9 (36%)	6 (46.15%)
	Mature (> 1 y)	14 (56%)	6 (46.15%)
Gender	Male	20 (80%)	6 (46.15%)
	Female	5 (20%)	7 (53.85%)
Breed	Small	8 (32%)	13 (100%)
	Medium	15 (60%)	0
	Large	2 (8%)	0
BCS	2	11 (44%)	5 (38.46%)
	3	12 (48%)	8 (61.54%)
	4	2 (8%)	0
Keeping	Indoor	9 (36%)	3 (23.08%)
	Outdoor	16 (64%)	10 (76.92%)
Accident type	Bite	3 (12%)	2 (15.38%)
	Hbc	20 (80%)	9 (69.23%)
	Gun	2 (8%)	1 (7.69%)
	Falling	0	1 (7.69%)
Open Fracture Grade	1	7 (28%)	4 (30.77%)
	2	13 (52%)	3 (23.08%)
	3	5 (20%)	6 (46.15%)
Surgery techniques	Plate	7 (28%)	1 (7.69%)
	ESF	7 (28%)	1 (7.69%)
	IMPC	11 (44%)	11 (84.62%)
Effected bone	Elbow	0	1 (7.69%)
	Femur	9 (36%)	4 (30.77%)
	Radius ulna	6 (24%)	0
	Tibia	4 (16%)	4 (30.77%)
	Tibia and Femur	0	1 (7.69%)
	Both tibia	0	1 (7.69%)
	Hock joint	2 (8%)	2 (15.38%)
	Humerus	4 (16%)	0
Fractured limb	Forelimb	10 (40%)	1 (7.69%)
	Hind limb	15 (60%)	12 (92.31%)
Site of fracture line	Distal	10 (40%)	5 (38.46%)
	Joint	1 (4%)	3 (23.08%)
	Middle	13 (52%)	5 (38.46%)
	Proximal	2 (8%)	0

BCS= Body condition score, Bite = Bite injuries, Hbc = car accident, Gun = Gunshot injuries, Falling= falling from a height, ESF = external skeletal fixation, IMPC= intramedullary pin and its combination

the detail of this patients were shown in Table 4. The number of post-operative infection dogs and cats in each three type of surgical techniques were shown in Table 5.

In this study, there were 22 patients (22/38, 57.89%) in the group of IM pin and its combinations. Of 22 IM pin and its combinations patients, there were 9 cases (9/38, 23.68%) with rush pin, 8 cases (8/38, 21.05%) with tie-in, 2 cases (2/38, 5.26%) with IM pin, 2 cases (2/38, 5.26%) with crossed pin, and 1 case (1/38, 2.63%) with tension band wire.

Using intramedullary pin and its combination techniques with open fractured dogs had 15 times risk of unsuccessful result than using external skeleton fixation (ESF) technique ($p < 0.03$). The postoperative complication in dogs using plate technique was not significantly different compared to ESF technique. In cats, cat with 3/5 BCS had 24 times risk of unsuccessful result compared to cat with 2/5 BCS ($p < 0.04$). The comparison of patients with and without postoperative infection (25 Dogs and 10 cats) were shown in Table 6. The identified bacteria from open fracture during the orthopedic surgery were shown in Figure 3. Seven bacteria from 25 sample of dog's surgical wound and 10 bacteria from 13 samples of cat's surgical wound were found at the time before closing the operation wound. Percentage of drug sensitivity and resistance for each bacteria was shown in Figure 4.

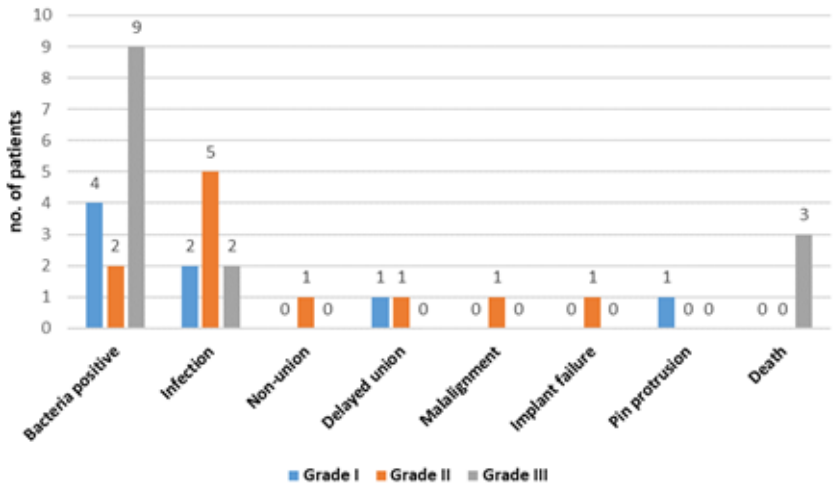

Figure 2 The presenting of major post-operative complications and the presenting of bacteria from surgical wound during the orthopedic surgery in each open fracture grade.

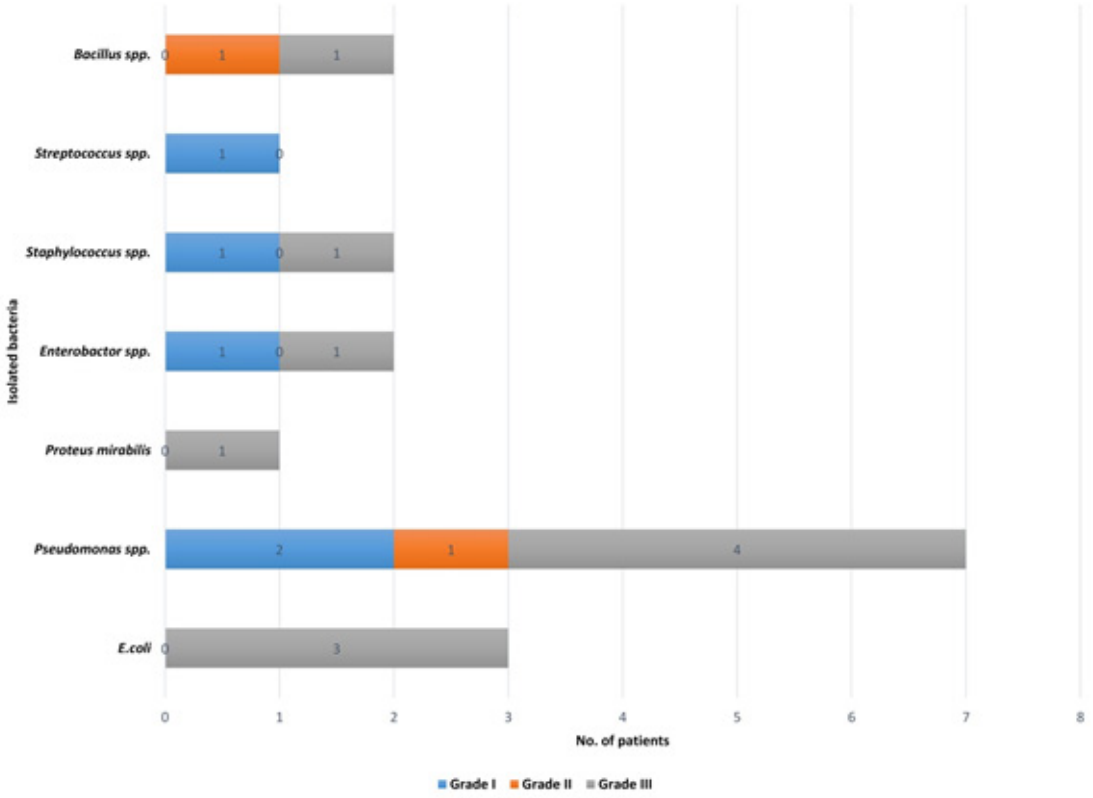

Figure 3 The detail of isolated bacteria are presenting in each grade of open fractured (I, II, III). The wound sampling was performed during orthopedic surgery before closing the operation wound in 25 dogs and 13 cats.

DISCUSSION

In this study, time from accident to surgery was not affected to the incidence of postoperative infection, similar to one study that reported the golden period of open fracture management could longer than 6 hours (Fernandes et al., 2015). The result of positive aerobic bacteria from the bone during the orthopedic surgery was not related to postoperative infection of the surgical wound or osteomyelitis which could be detected from the radiographic examination. Performing aerobic bacterial culture from the wound sample has limited benefit because of several reasons. Firstly, a wound sample might not representative all area, especially the contaminated and infected area. Secondly, a routine bacterial culture is time-consuming and incomprehension of all kind bacteria, especially anaerobic bacteria. Thirdly, the positive result of aerobic bacterial culture in this study had no statistically related to post-operative infection and the failure of treatment which similar to reports in human (Gustilo & Anderson, 2002; Lee, 1997).

Table 2 Perioperative factors to treatment succession in dogs (n = 25); succession define as dogs had lameness score less than grade 2; non-success defined as dogs had lameness score more than grade 1in the 9th week after orthopedic surgery.

Factors		Odds ratio (95% confidence interval)	p-value
Age	Pediatric &Young	0.12 (0.003-3.99)	0.2395
	Mature &Young	0.14 (0.01-1.52)	0.1080
Body size	Small &Medium	0.09 (0.01-0.79)	0.0293
	Large &Medium	0.16 (0.007-3.88)	0.2649
BCS	2 &3	0.77 (0.11-5.1)	0.7934
	4 &3	<0.001 (0->100)	0.9999
Keep	Outdoor &Indoor	2.2 (0.38-12.57)	0.3753
Calcium supplement	Given &Not given	2.33 (0.26-20.65)	0.4464
Accident type	Bite &Hbc	0.17 (0.01-2.42)	0.1955
	Gun &Hbc	0.35 (0.01-6.85)	0.4945
Open fracture grade	2 &1	0.16 (0.01-1.83)	0.1435
	3 &1	0.66 (0.03-14.03)	0.7942
Surgery techniques	Plate &ESF	>1000 (0->1000)	0.9999
	IMPC&ESF	15 (1.21-1.85)	0.0347
Fractured limb	HL &FL	2.2 (0.38-12.57)	0.3753
Site of fracture line	Prox. &Med	<-100 (<-1000->1000)	0.9999
	Distal &Med	6.43 (0.6-68.31)	0.1228
	Joint &Med	<-100 (<-1000->1000)	0.9999
Duration from Fracture onset to surgery		0.99 (0.97-1)	0.2534

BCS= Body condition score, Bite= bite injuries, Hbc= car accident, Gunt= gunshot injuries, ESF= external skeletal fixation, IMPC= intramedullary pin and its combination, HL= hind limbs, FL= fore limbs, Prox= proximal, Med=middle

Antibiotics administrating peri-operatively could be reduced the infection in mostly except multi-drug resistance bacterial infection (Gustilo & Williams, 1984; Halawi & Morwood, 2015; Perry, 2016). No growth of bacteria could be shown from the wound sample though sign of infection was shown. This can be explained by the sampling area had none of contaminated bacteria or the bacteria in the sample was weak from several reasons such as inappropriate media and transportation, thus, it cannot growth later in the laboratory (Gustilo, 1976; Gustilo, 1984; Matos, 2015; Samai, 2018). In addition, anaerobic bacteria can cause the infection which the routine bacterial culture cannot support them. However, bacterial identification and the antibiotic susceptibility test must be taken in each open fracture cases. Rapid technique to identify of bacteria species and antibiotic susceptibility test should be performed in the hospital such as automated ultra-high-throughput screen technology with a simple bacterial growth assay or culture-independent molecular techniques (Hannigan, Pulos, Grice, & Mehta, 2015; Sun et al., 2016).

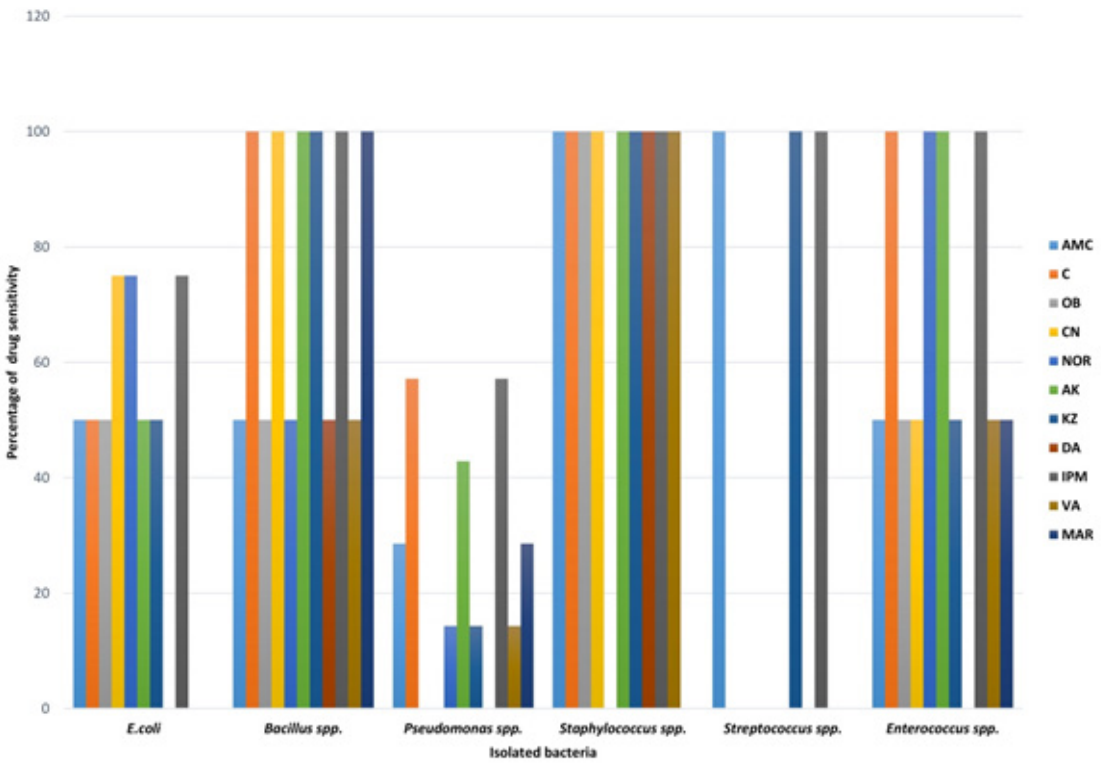

Figure 4 Percentage of antimicrobial sensitivity from disc diffusion test are presenting in each bacteria species that were isolated from the surgical wound during the operation. Ten antimicrobials were selected to perform in the test; AMC=Amoxycilin clavulanic acid, AK= Amikacin, C=Chloramphenical, CN=Gentamicin, OB=Cloxacilin, NOR=Norfloxacin, KZ=Cephazolin, DA=Clindamycin, IPM=Imipenem, VA=Vancomycin, MAR=Marbofloxacin.

Table 3 Perioperative factors to treatment succession in cats (n=13); succession define as cats had lameness score less than grade 2; non-success defined as cats had lameness score more than grade 1in the 9th week after orthopedic surgery)

Factors		Odds ratio (95% confidence interval)	p-value
Age	Pediatric & Young	<-1000 (<-1000->1000)	1.000
	Mature & Young	1000 (<1000-1000)	0.9999
Gender	Male & Female	5.33 (0.37-75.77)	0.2163
BCS	3 & 2	24 (1.14-505.17)	0.0409
Keep	Outdoor & Indoor	0.62 (0.04-9.64)	0.7364
Accident type	Bite & Hbc	0.5 (0.02-11.08)	0.6611
	Falling & Hbc	<-1000 (<-1000->1000)	0.9999
Open fracture grade	1 & 3	>1000 (<-1000- >1000)	0.9999
	2 & 3	1.99 (0.07-51.59)	0.6760
Surgery technique	Plate &ESF	<-1000 (<-1000->1000)	0.9999
	IMPC & ESF	0.5 (0.02-8.95)	0.6377
Site of fracture line	Distal & Med	0.16 (0.006-4.51)	0.2871
	Joint & Med	1.14 (0.9-1.44)	0.2531
Duration from Fracture onset to surgery		12.04 (0.16-883.41)	0.2562

BCS= Body condition score, Bite= bite injuries, Hbc= car accident, Falling= falling from a height, ESF= external skeletal fixation, IMPC= intramedullary pin and its combination

Table 4 The detail of 7 non-successfully patients; this patients had lameness score more than grade 1in the 9th week after orthopedic surgery from the total of 38 open fractured patients.

No.	Species	BCS	Etiology of fracture	Grade of open fracture	Fractured bone	Surgical techniques	Outcome
1	Cat	2/5	Bite	III	Olecranon	IMPC (Tension band wire)	Death
2	Cat	2/5	Hbc	III	Tibia	IMPC (Tie in)	Death
3	Cat	2/5	Hbc	III	Tibia	IMPC (Tie in)	Death
4	Cat	3/5	Bite	II	Tibia	ESF	WB at 17th week post-op
5	Cat	2/5	Hbc	III	Distal femur	IMPC (Rush pin)	Necrotic tissue, WB at 12th week post-op
6	Dog	2/5	Gun	II	Humerus	ESF	Post-op severe infection then amputation
7	Dog	3/5	Hbc	II	Distal femur	IMPC (Rush pin)	Post-op infection, WB at 25th week post-op

Bite= Bite injuries, Hbc = car accident, Gun = Gunshot injuries, ESF= external skeletal fixation, IMPC= Intramedullary pin and its combination, Post-op=postoperative, WB= weight bearing and lameness score < 2

Table 5 The number of post-operative complications of dogs and cats in each fracture fixation techniques. Some patients had more than one complication postoperatively (n=38).

Post-operative outcome	Plate (n= 8)	ESF (n= 8)	IMPC(n=22)
Infection	0	5	3
Non-union	0	1	0
Delayed-union	1	1	0
Malalignment	1	0	0
Implant failure (loosening)	0	0	2
Death	0	0	3

ESF= external skeletal fixation, IMPC= Intramedullary pin and its combination

IM pin and/or its combination techniques should be avoided to apply with open fractured patient, especially in dogs because of high incidence of infection was found when compared with using external skeleton fixation in this study and also reported in several studies (Inan, Halici, Ayan, Tuncel, & Karaoglu, 2007; Yokoyama et al., 2008). However, Intramedullary devices can be used with grade I and II open fractures, but the placing of an intramedullary device in a contaminated or infected fracture may spread out the bacterial contamination to the entire medullary cavity (Newton & Nunamaker, 1985).

However, some beneficial of intramedullary devices such as Plate-rod and interlocking nail in open fracture had reported in human i.e. effectively in developing more stability, less complications, no incidence of re-fracture and faster bone union (Aslani, Tabrizi, Sadighi, & Mirblok, 2013; Gill et al., 2016; Ramseier, Bhaskar, Cole, & Howard, 2007) then decision to apply IM pin and/or its combination techniques in open fracture patients must be considered case by case. The reason to select IM pin and its combination in this study were the patient's intolerance of ESF and the limiting of financial support by the owners. Open fractured with underweight cats had higher success rate of treatment than ideal body condition score cats. This finding is conformable as one of the studies that show the positive relation between incidence of non-union and heavier cats (Nolte, Fusco, & Peterson, 2005).

The system that used to classify the severity of open fracture in this study was following the initial Gustilo-Anderson classification system (Gustilo & Anderson, 1976). This classification system has a broad detail of each open fracture grade but convenient to use in the clinic. However, it had showed not significantly related to the final outcomes. Thus, the use of higher resolution of open fracture grading system as the refined Gustilo Classification System of Open Fractures (Gustilo, Mendoza, & Williams, 1984); classifying into grade I, II, IIIa, IIIb, and IIIc should be considered in the further study. In addition, the severity of skin, muscle, arterial injury, contamination, and bone loss should also be classified as following the guideline in human (Born, 1999) to have an accurate prediction key point.

Table 5 comparison of the patients with and without post-operative signs of infection (25 Dogs and 10 cats)

Variable		Post-op Infection	(%)	Post-op no Infection	(%)	p-value
Total		8	22.86	27	77.14	
Sex	Male	7	87.5	19	70.37	
	Female	1	12.5	8	29.63	
Age	<1mt	1	12.5	1	3.70	
	1-8 mt	2	25	11	40.74	
	>8mt	5	62.5	15	78.95	
Size	Small	5	62.5	13	48.15	
	Median	2	25.00	13	48.15	
	Large	1	12.5	1	3.70	
BCS	1	0	0	0	0	
	2	4	50	12	44.44	
	3	3	37.5	17	62.96	
	4	1	12.5	1	3.70	
Etiology	Hbc	5	62.5	22	81.48	
	Gun	1	12.5	2	7.41	
	Falling	0	0	1	3.70	
	Bite	2	25	2	7.41	
Grade of open fracture	1	1	12.5	10	37.04	
	2	5	62.5	11	40.74	
	3	2	25	6	22.22	
Fixation technique	Plate	0	0	8	29.63	
	ESF	5	62.5	3	11.11	
	IMPC	3	37.5	16	59.26	
Onset-Sx (hr)*	Average±SD	72.5 ± 84.22		33.26 ± 43.62		0.230
	Min	12		3		
	Max	240		216		
Sx-Wb (d)**	Average±SD	80±57.81		34.69±20.59		0.200
	Min	30		21		
	Max	180		120		

Post-op= post-operative, mt= month, BCS= Body condition score, Hbc= car accident, Gun= gunshot injuries, Falling= falling from a height, Bite= bite injuries, ESF= external skeletal fixation, IMPC= intramedullary pin and its combination, * Onset-Sx (hr) = Duration from Fracture onset until orthopedic surgery (hour), ** Sx-Wb (d) = Duration after orthopedic surgery until the patient can weight-bearing on effected limb and lameness score <2 (day), min= minimum, max= maximum

According to evaluation the risk of anesthesia and surgery, routine blood work must be performed in all patients. Patients with abnormal blood results need to be stabilized or treated before deciding for surgery. However, from the result of this study, only performing routine blood work is insufficient in open fractured cats. Testing of feline viral infection is strongly recommended to perform before surgery in all cats, especially outdoor cat. Cat with history of immunosuppressive diseases and has a normal to high white blood cell count before surgery could develop severe signs of the feline viral infection after surgery. This study found that all of positive FeLV infection cats were died within the first week after the orthopedic surgery from a sudden severe leukopenia, anorexia and hypothermia. One of the cats with positive feline immunodeficiency virus (FIV) test had delay union but survived and its bone was healed.

Although this study had some findings relevant to the better understanding of the surgical outcomes of open fracture in dogs and cats, it has some limitations. The present study is clinically studied focusing on the animal population in the northern part of Thailand which has a tropical climate. Therefore, this study may not be a representative of worldwide open fracture in small animals. Due to the short period of the study, the samples size of open fracture patients was smaller than in the previously study (Millard & Weng, 2014).

CONCLUSION

The identification of factors associated with the outcomes of open fracture treatment at the first evaluation is crucial. Positive of feline viral infection indicates poor prognosis. Thus, rapid viral infection test should be tested before surgery. Application with IM pin and its combination techniques are not recommended in all cases of open fracture, especially in dogs. Moreover, underweight cats had higher success rate compared to cats with ideal body condition score. Those following factors; age, sex, breed, etiology of fracture, fracture classification, housing, duration of accident until surgery, effected bone, site of fracture were not significantly associated with the outcomes of open fracture in dogs and cats. Bacteria culture and antimicrobial susceptibility test from the open wound had given a little information and benefit, however, it should be performed in all cases.

CONFLICS of INTEREST

There is no conflict of interest associated with this study and this manuscript.

ACKNOWLEDGEMENT

The authors would like to thank the Small Animal Teaching Hospital, Faculty of Veterinary Medicine, Chiang Mai University for providing an access to the medical data bases and a support for this study.

REFERENCES

Aslani, H., Tabrizi, A., Sadighi, A., & Mirblok, A. R. 2013. Treatment of open pediatric tibial fractures by external fixation versus flexible intramedullary nailing: a comparative study. Arch Trauma Res, 2, 108-112. doi:10.5812/atr.13826

Born, C. T. 1999. Guidelines for orthopaedic trauma fellowships. Orthopaedic trauma association, fellowship and career choices committee. J Orthop Trauma, 136, 437-440.

Fernandes, C., Peres, L. R., de Queiroz, A. C., Jr., Lima, J. Q., Jr., Turibio, F. M., & Matsumoto, M. H. 2015. Open fractures and the incidence of infection in the surgical debridement 6 hours after trauma. Acta Ortop Bras, 23, 38-42. doi:10.1590/1413-78522015230100932

Gill, S. P., Raj, M., Kumar, S., Singh, P., Kumar, D., Singh, J., & Deep, A. 2016. Early conversion of external fixation to interlocked nailing in open fractures of both bone leg assisted with vacuum closure (VAC) - final outcome. J Clin Diagn Res, 10, Rc10-14. doi:10.7860/jcdr/2016/17612.7265

Gustilo, R. B., & Anderson, J. T. 1976. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am, 58, 453-458.

Gustilo, R. B., & Anderson, J. T. 2002. JSBS classics. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones. Retrospective and prospective analyses. J Bone Joint Surg Am, 84, 682.

Gustilo, R. B., Mendoza, R. M., & Williams, D. N. 1984. Problems in the management of type III (severe) open fractures: a new classification of type III open fractures. J Trauma, 24, 742-746.

Gustilo, R. B., & Williams, D. N. 1984. The use of antibiotics in the management of open fractures. Orthopedics, 7, 1617-1619. doi:10.3928/0147-7447-19841001-14

Halawi, M. J., & Morwood, M. P. 2015. Acute management of open fractures: An evidence-based review. Orthopedics, 38, e1025-1033. doi:10.3928/01477447-20151020-12

Hannigan, G. D., Pulos, N., Grice, E. A., & Mehta, S. 2015. Current concepts and ongoing research in the prevention and treatment of open fracture infections. Adv Wound Care (New Rochelle), 4, 59-74. doi:10.1089/wound.2014.0531

Inan, M., Halici, M., Ayan, I., Tuncel, M., & Karaoglu, S. 2007. Treatment of type IIIA open fractures of tibial shaft with Ilizarov external fixator versus unreamed tibial nailing. Arch Orthop Trauma Surg, 127, 617-623. doi:10.1007/s00402-007-0332-9

Lee, J. 1997. Efficacy of cultures in the management of open fractures. Clin Orthop Relat Res 339, 71-75.

Millard, R. P., & Weng, H. Y. 2014. Proportion of and risk factors for open fractures of the appendicular skeleton in dogs and cats. J Am Vet Med Assoc, 245, 663-668. doi:10.2460/javma.245.6.663

Newton, C. D., & Nunamaker, D. M. 1985. Textbook of small animal orthopaedics: Lippincott.

Nolte, D. M., Fusco, J. V., & Peterson, M. E. 2005. Incidence of and predisposing factors for nonunion of fractures involving the appendicular skeleton in cats: 18 cases (1998-2002). J Am Vet Med Assoc, 226, 77-82.

Perry, K. L., & Bruce, M. 2015. Impact of fixation method on postoperative complication rates following surgical stabilization of diaphyseal tibial fractures in cats. Vet Comp Orthop Traumatol, 28, 109-115. doi:10.3415/vcot-14-08-0120

PerryBVM, K. L., & MRCVS, S. C. D. F. 2016. Management of open fractures: part 1. Companion Animal, 21, 165-170. doi:10.12968/coan.2016.21.3.165

Ramseier, L. E., Bhaskar, A. R., Cole, W. G., & Howard, A. W. 2007. Treatment of open femur fractures in children: comparison between external fixator and intramedullary nailing. J Pediatr Orthop, 27, 748-750. doi:10.1097/BPO.0b013e3181558b00

Sun, W., Weingarten, R.A., Xu, M., Southall, N., Dai, S., Shinn, P., Sanderson, P.E., Williamson, P.R., Frank, K.M., Zheng, W., 2016. Rapid antimicrobial susceptibility test for identification of new therapeutics and drug combinations against multidrug-resistant bacteria. Emerg Microbes Infect 5, e116. doi:10.1038/emi.2016.123

Utvag, S. E., Korsnes, L., Rindal, D. B., & Reikeras, O. 2001. Influence of flexible nailing in the later phase of fracture healing: strength and mineralization in rat femora. J Orthop Sci, 6, 576-584. doi:10.1007/s007760100015

Yokoyama, K., Itoman, M., Uchino, M., Fukushima, K., Nitta, H., & Kojima, Y. 2008. Immediate versus delayed intramedullary nailing for open fractures of the tibial shaft: a multivariate analysis of factors af fecting deep infection and fracture healing. Indian J Orthop, 42, 410-419. doi:10.4103/0019-5413.43385

How to cite this article;

Areerath Akatvipat and Luddawon Somrup. Incidence of post-operative infection and the factors associated with surgical outcomes in 25 dogs and 13 cats with open fracture. Veterinary Integrative Sciences. 2018; 16(3): 247-269