J Vet Clin 22(1) : 6-15(2005)

Effects of Butorphanol on Behavior after Intestinal Anastomosis in Dogs

Ja-min Koo, Hee-chun Lee, Hong-hee Chang, Yong-jeung Seong, Hyo-jong Lee and Seong-chan Yeon[1]

Institute of Animal Medicine, College of Veterinary Medicine, Gyeongsang National University, Jinju 660-701, Korea

Abstract : This study was performed to investigate non-invasive behavioral pain assessment of dogs after surgery, and the analgesic effects of butorphanol after intestinal anastomosis in dogs. In this study, five dogs in the Control Group were anesthetized, but did not undergo surgery. Five dogs in the Analgesic Group were undergone intestinal anastomosis and treated with butorphanol. Five dogs in the Non-analgesic Group were also undergone intestinal anastomosis without analgesic treatment. The dogs in the Analgesic Group received butorphanol (0.4 mg/kg, IM) before and immediately after operation, while dogs in Control and Non-analgesic Groups received isovolumetric doses of sterile saline. The behavior of dogs were videotaped for 400 mins after anesthesia, during which time a researcher interacted with the dog once per each 80 mins. At each interaction, the researcher recorded behavioral pain score, using University of Melbourne Pain Scale. Interactive and non-interactive behaviors were observed and quantitated by a single observer using focal continuous sampling method. Vocalizations were obtained during 400 mins after anesthesia, and duration of call, intensity, pitch, 1-4 Formant were analyzed. Surgery affected an increasing of pain score. During interactions with researcher, greeting behaviors were decreased after surgery. Differences between Analgesic group given analgesic or that given a placebo drug were readily understood using quantitative behavioral measurements and vocalization. Significant difference between Analgesic group given butorphanol or that the given placebo drug was apparent($p<0.05$).

Key words : behavior, butorphanol, canine, intestinal anastomosis, pain.

Introduction

According to the International Association for the Study of Pain(IASP) has defined pain as "the unpleasant sensory and/or emotional experience associated with actual or potential tissue damage". Lamont *et al*[13] and Hellebreker[18] said that recently pain has been called the fifth sense and its significance is increasing. Continuity of pain is related to extension of disease treatment as well as the welfare aspect for an animal or a human, which extends the possibility of secondary side effects or hospitalization time.

Therefore, it is essential for a clinical veterinarian to understand the pain of animals. He/she should know when pain occurs, how long it endures and how it responds to treatment.

Despite the fact that numerous clinical veterinarians accept that animals feel pain, basic information about animals pain is deficient. Although the interest in pain is growing and the use of analgesics is emphasized and has increased, the use of analgesics has been limited in current veterinary clinics. Mathews[11] and Hardie[19] claimed that the reason that the use of analgesics is limited is because no adequate evaluation for animals pain has been established. Furthermore, people tend to be hesitant to use analgesics worrying about the side effects, including change in heartbeat, breathing, toxicity, and adverse effects. However, this might be a negative preconception toward analgesics[15].

Clinical symptoms of pain in animals are broad from the subtle to the clear. These are due to the differences in levels, kinds, and degrees of pain, and individuals. The most generally applied evaluation method is to measure an animals reaction to pain and it must be assured that the evaluation is performed on the basis of physiological or behavioral reactions. Changes in heartbeat, breathing, and temperature, salivation, and lameness are to be evaluated for physiological reactions[2,10,17,28] while behavioral reactions are evaluated on the changes in posture, the state of the animal, movement, and vocalization[8,12,21,22,28]. Previous researches were studied about pain or analgesics based upon physiological reactions. Recent researches studying behavioral reactions, which are fast and noninvasive methods, allow obtaining evaluations of animal pain more easily.

The purpose of this research is to establish an evaluation method on pain after surgery through noninvasive behavioral observations of dogs and to determine the effect of butorphanol after intestinal anastomosis performed in dogs.

Materials and Methods

Animals

Fifteen female mixed-breed dogs were tested; they were recognized as healthy through CBC and serum chemistry, under the same feeding conditions of 4-6 kg per weight and of 1-3 years olds.

Dogs were classified into Control group which consisted of female dogs that were put under anesthesia only, Analgesic group in which intestinal anastomosis was carried out and analgesics were provided after surgery, Non-analgesic group in which intestinal anastomosis was performed after anesthesia and no analgesics were provided after surgery. Five female dogs were applied in each experimental group.

[1]Corresponding author.
E-mail : scyeon@nongae.gsnu.ac.kr

Anesthesia and Intestinal Anastomosis

The dogs were put in a state of fasting for 24 hours prior to surgery and 20 mg/kg of cefalexin sodium(Cefalexin sodium, Yooyoung, Korea) was supplied intravenously, 20 minutes before surgery. Saline and glycopyrrolate(Glycopyrrolate, Reyon, Korea) were applied intramuscularly by 0.02 mg/kg to Control group and Non-analgesic group. In Analgesic group, a muscle injection of glycopyrrolate and 0.04 mg/kg of butorphanol tartrate(Butorphan, Myoungmun, Korea) was practiced by 0.02 mg/kg for preanesthesia. Then, anesthetic induction was performed with 4-6 mg/kg propofol(Anepol, Hana, Korea). After that, isoflurane(Isoflurane, Rhodia, UK) was applied to maintain general anesthesia.

In this research, propofol was applied for anesthetic induction to minimize the effects of pain from the anesthetic. Any medicine that might influence pain in the subject was excluded. The same surgeon in Analgesic group and Non-analgesic group performed intestinal anastomosis. After surgery, the dogs were transferred to recovery cages isolated from the outside and observation was carried out.

As for the analgesics applied, saline was injected in experimental Control group and Non-analgesic group and butorphanol tartrate (0.4 mg/kg) was applied by an intramuscular injection for experimental Analgesic group right after anesthesia, right after surgery, and three hours later, respectively.

Observation of Behavior after Anesthesia and Surgery

Video recording was conducted for all dogs in the isolated recovery cages in order to observe their behavior after anesthesia and surgery. Digital palmcorders(Panasonic PV-DV400, Japan) were installed 1.5 m above the cages and recording was carried out for 400 minutes.

Analysis of Behavior

A trained person analyzed the recorded tape. A continuous focal sampling method was applied for behavior analysis. A total of 100 behavior patterns were observed according to non-interactive behavior and interactive behavior that was subdivided into the observers petting or examining the operated area by palpation.

1) Observation of behavior

A total of 100 behavior patterns were observed focusing on posture, movement, physical condition, eye shape and line of sight, existence of vocalization and its type, the shape of the head, ears, and tail, and other behavior patterns(Table 1). Among them, mental state of the dogs were evaluated based

Table 1. Items for behavioral observation

Aspect of behavior	Items of observation
Posture(12)	Stand(ST), Lateral recumbency(LR), Sternal recumbency(SR), Praying position(PP), Curled up(CU), Sit(SI), Sitting arched back(AB), Position ataxia(PA), Standing arched back(STA), submissive position Standing with head drop(STD), Sitting with head drop(SID)
Movement(11)	Walking(WA), Back-walking(BWA), Cage circling(CC), Hobbles(HOB), No movement when not sleeping (NM), No movement when not sleeping in stand(NMST), Belly presented(BE), Movement ataxia(MA), Hopping(HO), Running(RU), Walking slowly(WAS)
State(10)	Awake(AW), Asleep(AS), Depression(DP), Piloerection(PE), Piloerection restricted to neck or tail region (PR), Trembling(TR), Thrashing(THR), Restless(RE), Paddling(PD), Exciting(EX)
Eye(9)	Stare ahead(SA), Watch(WT), Lidded closed(LC), Stare backward(SB), Direct gaze(DG), Averted gaze (AG), Narrowed(NA), Blinking(BL), Big(BG)
Head(4)	Head lifts(HL), Head drops(HD), Head nodding(HN), Head rest on surface(HR)
Ear(4)	Ear erect(EE), Ear back(EB), Ear flattened(EF), Ear totally flattened(ETF)
Mouth(9)	Mouth curled(MC), Mouth drawn back(MD), Licking lips(LL), Open mouth(OM), Muzzle wrinkled (MW), Muzzle smooth(MS), snarl/growl with only incisiors and canines apparent(SNI), snarl/growl with all teeth and back of throat apparent(SNA), grin(GN)
Tail(9)	Tail tucked(TT), Tail Wag(TW), Tail tip wag(TTW), Weak tail wag(WTW), Tail below horizon(TBH), Tail above horizon(TAH), Tail on surface(TS), Tail tucked when belly presented(TB), Tail tucked when belly presented with urination(TU)
Vocalization(12)	Screaming(SCR), Constant screaming(C-SCR), Whining(WH), Constant whining(C-WH), Barking(BA), Constant barking(C-BA), Growing(GW), Constant growing(C-GW), Moaning(MO), Constant Moaning (C-MO), Howling(HW), Constant howling(C-HW)
Miscellaneous(20)	Licking(LI), Chewing(CH), Grooming(GR), Sniffing(SN), Cage licking(CL), Cage digging(CD), Cage pawing(CP), Cage biting(CB), Vomiting(VO), Salivation(SAL), Escape(ES), Urination(UR), Urination in lateral recumbency(URL), Defecation(DE), Defecation in lateral recumbency(DEL), Startle(STT), Rasing forepaw(RF), Panting(PT), Aggression(AGG), Biting(BI)

on the shape of the head, ears and tail, line of sight and eye shape.

2) Observation of behavior according to situation

A total of 100 behavior patterns were observed according to a non-interactive behavior or interactive behavior situation.

An interactive behavior situation was when an observer was present in order to change the videotape. First, the observer called the dog's name making eye contact, and then petted the whole body of the subject. Lastly, he examined the operated area of the subject. Each area was recorded for one minute, which summed up to 3 minutes in total. Recording occurred 4 times each, which produced a total of 12 minutes of observation in the interactive situation. The behaviors recorded for the initial four minutes after an observer's visit were excluded.

Analysis of Voices

The vocal sounds of all dogs that were measured during the observation period were collected by Cool Edit(Syntrillum, USA) and analyzed through Praat(Paul Boersma, The Netherlands). The voices were measured and analyzed by sound duration, intensity, and pitch of calls and the 1-4 Formant that indicates energy intensity in the specific frequency band.

Pain Scoring

After analyzing all observed behaviors, the levels of pain were analyzed for comparison by the pain scale of the University of Melbourne that Firth *et al*[6] applied in 1999. Reactions to pain, physiological changes, reaction to palpation, activity state, mental state, and changes in posture, and vocalization were observed. Then, the levels of pain were compared, one to another. However, physiological changes were not measured in this research in order to exclude any interference effect that could be generated by a physiological measuring method during the behavioral observation process. The level of pain was evaluated by the sum of points for each reaction. The pain score 0 indicated no pain and pain score 16 was interpreted that the pain was serious (Table 2).

Statistical Analysis

The results obtained in this experiment were analyzed through statistical analysis with SPSS 9.0. The significance was verified through the Kruskal Wallis test ($p < 0.05$) for

Table 2. Pain Scale

Category	Descriptor	Score
Response to palpation choose only one	No change from preprocedural behavior	0
	Guards/reacts* when touched	2
	Guards/reacts* before touched	3
Activity choose only one	At rest sleeping	0
	-semiconscious	0
	-awake	1
	Eating	0
	Restless(pacing continuously, getting up and down)	2
	Rolling, Thrashing	3
Mental state choose only one	Submissive	0
	Overtly friendly	1
	Wary	2
	Aggressive	3
Posture choose only one	Guarding or protecting affected area	2
	Lateral recumbency	0
	Sternal recumbency	1
	Sitting or standing, head up	1
	Standing, head hanging down	2
	Moving	1
	Abnormal posture(eg. prayer position, hunched back)	2
Vocalization** choose only one	Not vocalization	0
	Vocalizing when touched	2
	Intermittent vocalization	2
	Continuous vocalization	3

*Includes turning head toward affected area
**Does not include alert barking
0=Behavior that was the antithesis of pain, 1=Behavior that was neither antithetic nor indicative of pain
2=Behavior that indicated mild or moderate pain, 3=Behavior that indicated severe pain

pain scores and the General Linear Model ($p < 0.05$) was applied for the dog's call.

Results

Analysis of Behavior

Among 100 behavior items during 400 minutes of the observation period after anesthesia and surgery, a total of 75 were observed and identified.

As for the posture of the dogs after anesthesia and surgery, in case of non-interactive behavior, the frequencies of ST were 31.9% in Control group, 24.4% in Analgesic group, and 18.2% in Non-Analgesic group. The frequencies of SI were 15.7% in Control group, 23.7% in Analgesic group, and 33.6% in Non-Analgesic group. The frequencies of LR were 34.4% in Control group, 24.7% in Analgesic group, and 5.1% in Non-Analgesic group. Those in CU were 0.0% in Control group, 5.6% in Analgesic group, and 13% in Non-Analgesic group. Those in STA were 0.0% in Control group, 8.6% in Analgesic group, and 56.6% in Non-Analgesic group. The frequencies of STD were 17.2% in Control group, 45.9% in Analgesic group, and 74.5% in Non-Analgesic group. The frequencies of AB were 1.3% in Control group, 52.7% in Analgesic group, and 96.6% in Non-Analgesic group. As for interactive behavior, the ST frequencies were 63.8% in Control group, 56.6% in Analgesic group, and 10.2% in Non-Analgesic group. The SI frequencies were 13.8% in Control group, 17% in Analgesic group, and 61.5% in Non-Analgesic group, which shows differences in the three groups(Fig 1-3).

The occurrence frequencies of movement during the observation period were as follows. In case of non-interactive behavior, NM frequencies were 67.7% in Control group, 30.6% in Analgesic group, and 89% in Non-Analgesic group. The NMST frequencies were 20.5% in Control group, 75.5% in Analgesic group, and 2.4% in Non-Analgesic group. In interactive behavior, the NM frequencies were 25% in Control group, 48.5% in Analgesic group, and 77.6% in Non-Analgesic group while the WAS frequencies were 0.0% in Control group, 2.3% in Analgesic group, and 14.1% in Non-Analgesic group. The HO frequencies were 38% in Control group, 12% in Analgesic group, and 0.0% in Non-Analgesic group. The BE frequencies were 15% in Control group, 3.2% in Analgesic group, and 0.0% in Non-Analgesic group, which indicates differences in the three groups(Fig 4, 5).

As for the occurrence frequencies in head posture, in non-interactive behavior, the HL frequencies were 57.7% in Control group, 42.6% in Analgesic group, and 42.3% in Non-Analgesic group, which displays differences(Fig 6). Also in non-interactive behavior, the number of changes in posture and movement were 735.6 times in Control group, 385.7 times in Analgesic group, and 258.4 times in Non-Analgesic group, while changes in the line of sight were 1159.6 times in Control group, 689.3 times in Analgesic group, and 472.4 times in Non-Analgesic group. In interactive behavior, changes in postures were 70.4 times in Control group, 21.2 times in Analgesic group, and 12.5 times in Non-Analgesic group, while

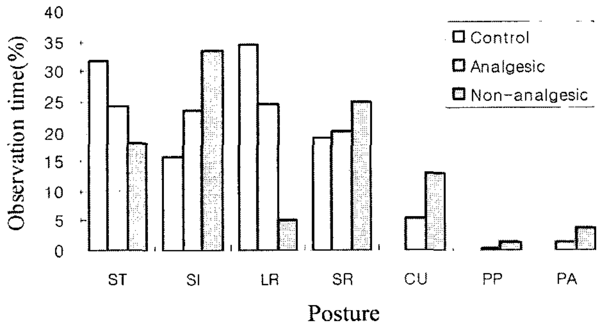


Fig 1. The comparison of posture after intestinal anastomosis in dogs(non-interactive).
Control: anesthesia only, Analgesic: the group treated with butorphanol and propofol/isoflurane and intestinal anastomosis performed, Non-analgesic: the group treated with saline and propofol/isoflurane and intestinal anastomosis performed. ST: standing, SI: sit, LR: lateral recumbency, SR: sternal recumbency, CU: curled up, PP: praying position, PA: position ataxia.

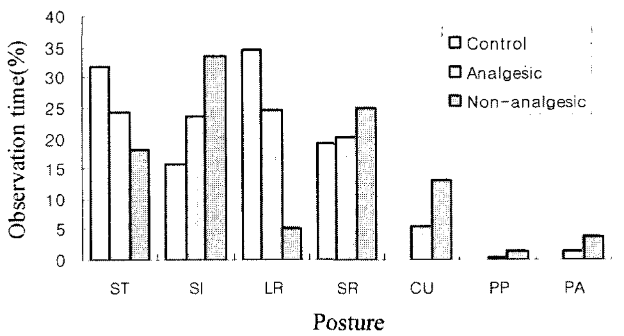


Fig 2. The comparison of posture between three groups(interactive : 12 min).
ST: standing, SI: sit, LR: lateral recumbency, SR: sternal recumbency, CU: curled up, PP: praying position, PA: position ataxia.

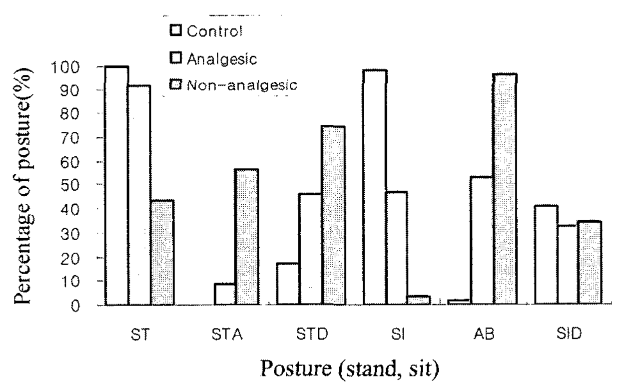


Fig 3. The comparison of posture(stand, sit) between three groups(non-interactive).
ST: standing, STA: standing arched back, STD: standing with head drop, SI: sit, AB: arched back, SID: sit with head drop.

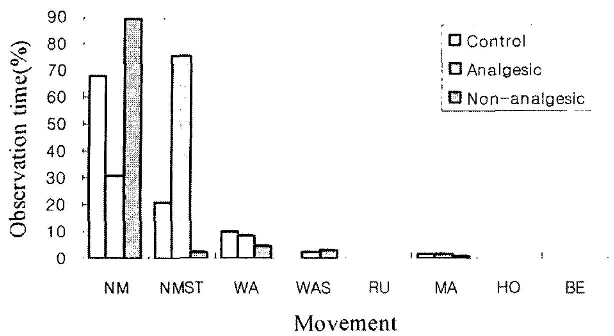


Fig 4. The comparison of movement between three groups(non-interactive).
NM: no movement when not sleeping, NMST: no movement when not sleeping in stand, WA: walking, WAS: walking slowly, RU: running, MA: movement ataxia, HO: Hopping, BE: belly presented.

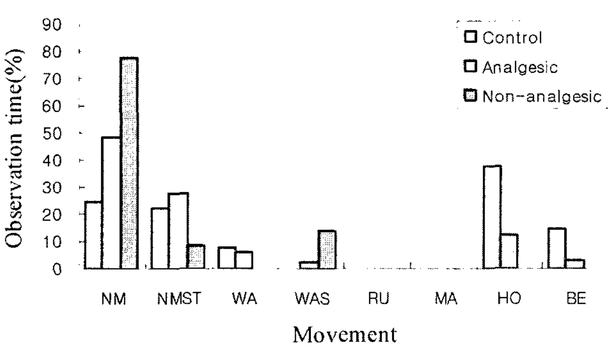


Fig 5. The comparison of movement between three groups (interactive : 12 min).
NM: no movement when not sleeping, NMST: no movement when not sleeping in stand, WA: walking, WAS: walking slowly, RU: running, MA: movement ataxia, HO: Hopping, BE: belly presented.

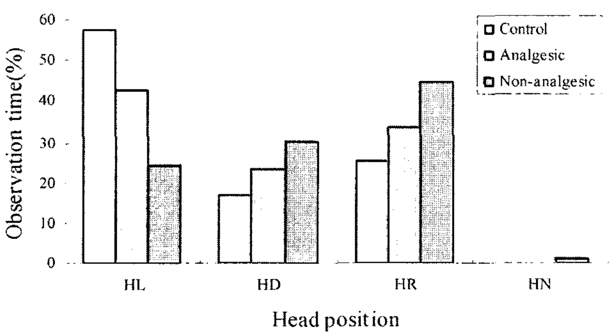


Fig 6. The comparison of head position between three groups (non-interactive).
HL: head lift, HD: head drop, HR: head rest on surface, HN: head nodding.

changes in movement were 102.6 times in Control group, 40.2 times in Analgesic group, and 12.1 times in Non-Analgesic

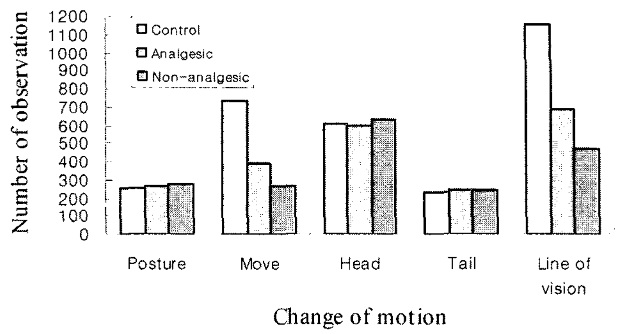


Fig 7. The comparison of motion change between three groups (non-interactive).

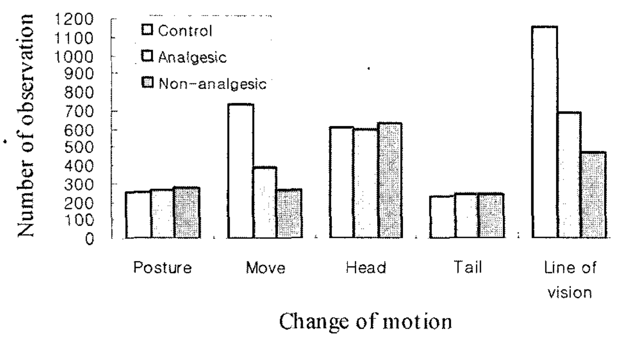


Fig 8. The comparison of motion change between three groups (interactive : 12 min).

group, which demonstrates differences among the three groups (Fig 7, 8).

Among other behavior occurrence frequencies, the LI frequencies were 29.6 minutes in Control group, 5.7 minutes in Analgesic group, and 2.8 minutes in Non-Analgesic group. The CH frequencies were 3.5 minutes in Control group, 5.2 minutes in Analgesic group, and 9.8 minutes in Non-Analgesic group. The GR frequencies were 7.1 minutes in Control group, 0.0 minutes in Analgesic group, and 0.0 minutes in Non-Analgesic group. The RF frequencies were 19.2 times in Control group, 3.93 times in Analgesic group, and 1.2 times in Non-Analgesic group. The AGG frequencies were 0.0 times in Control group, 0.0 times in Analgesic group, and 0.4 times in Non-Analgesic group. The BI frequencies were displayed 0.0 times in Control group, 0.0 times in Analgesic group, and 0.2 times in Non-Analgesic group. The CB frequencies were 0.0 times in Control group, 0.3 times in Analgesic group, and 3.1 times in Non-Analgesic group. CD was demonstrated at 8.4 times in Control group, 0.0 times in Analgesic group, and 0.0 times in Non-Analgesic group, which shows differences (Fig 9, 10).

Analysis of Voices

As for the voices measured during the experiment period, there were differences among the three groups in MO, C-MO, SCR, and C-SCR(Fig 11).

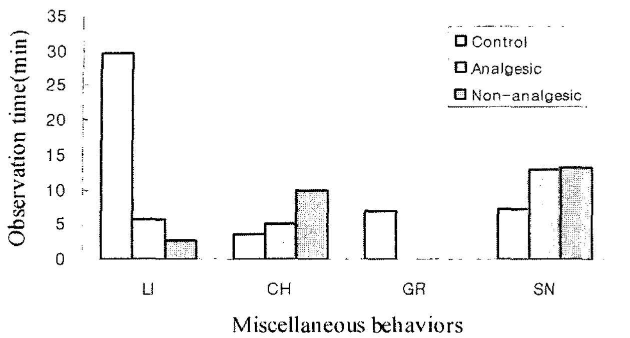


Fig 9. The comparison of miscellaneous behavior between three groups(non-interactive).
LI: licking, CH: chewing, GR: grooming, SN: sniffing.

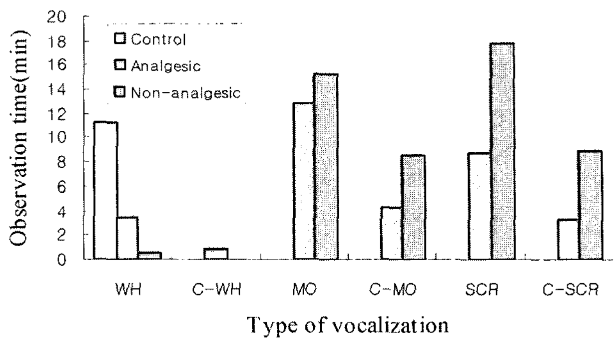


Fig 11. The comparison of vocalization between three groups. WH: whining, C-WH: constant whining, MO: moaning, C-MO: constant moaning, SCR: screaming, C-SCR: constant screaming.

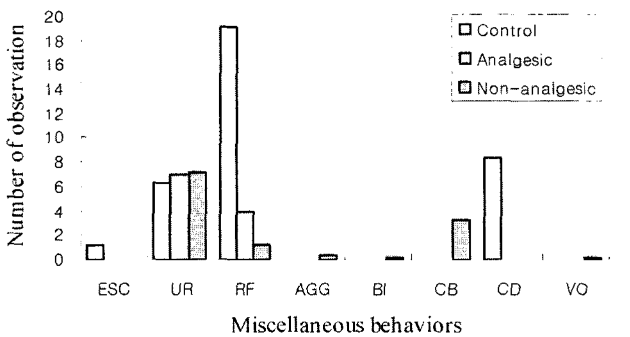


Fig 10. The comparison of miscellaneous behavior between three groups(interactive : 12 min).
ESC: escape, UR: urination, RF: rasing forepaw, AGG: aggression, BI: biting, CB: cage biting, CD: cage digging, VO: vomiting.

In vocal analysis using Praat, significant differences ($p <$ 0.05) were displayed between Analgesic group and Non-Analgesic group in duration, the pitch of the call, and as well as in first Formant, second Formant, third Formant, and fourth formant that represent sound energy in special frequency of the call(Table 3, Fig 12, 13).

Pain Score

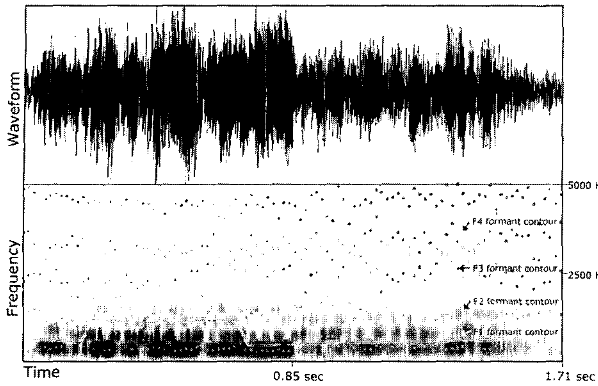
Results of applying interactive behavior to the pain scale: 1.6 points in Control group, 7.6 points in Analgesic group, and 14.2 points in Non-Analgesic group were represented the first observation time. As for the second observation time, 1.2 points in Control group, 6.8 points in Analgesic group, and 13.4 points in Non-Analgesic group were recorded. On the third observation time, 1.2 points in Control group, 5.8 points in Analgesic group, and 12.6 in Non-Analgesic group were obtained. On the fourth observation time, the results were 1.2 points in Control group, 5.2 points in Analgesic group, and 12.6 in Non-Analgesic group. For interactive behavior, 1.2 points in Control group, 6.4 points in Analgesic group, and 13.6 points in Non-Analgesic group were shown, which indicates that the values of Control group and Analgesic group are significantly low ($p < 0.05$) compared to Non-Analgesic group(Fig 14).

Discussion

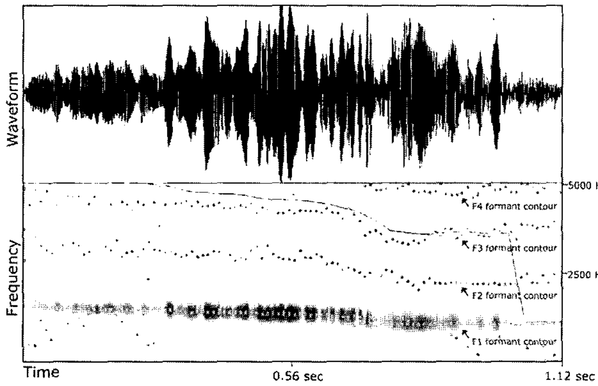
All animals experience pain and express it in peculiar ways.

Table 3. Summary statistics of acoustic variables of Moaning($^*p<0.05$)

Duration of call (sec)	analgesic	1.716	.229	.000*
	non-analgesic	1.122	.297	
Pitch (Hz)	analgesic	250	30	.000*
	non-analgesic	400	44	
Intensity (dB)	analgesic	43.267	.759	.371
	non-analgesic	41.233	6.965	
1 Formant (Hz)	analgesic	590	63	.000*
	non-analgesic	1238	243	
2 Formant (Hz)	analgesic	1375	32	.000*
	non-analgesic	1556	122	
3 Formant (Hz)	analgesic	2460	337	.005
	non-analgesic	2875	240	
4 Formant (Hz)	analgesic	3556	141	.001*
	non-analgesic	3918	248	

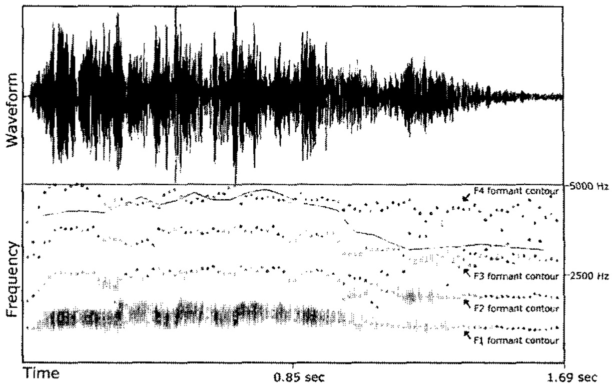


(A) Analgesic group

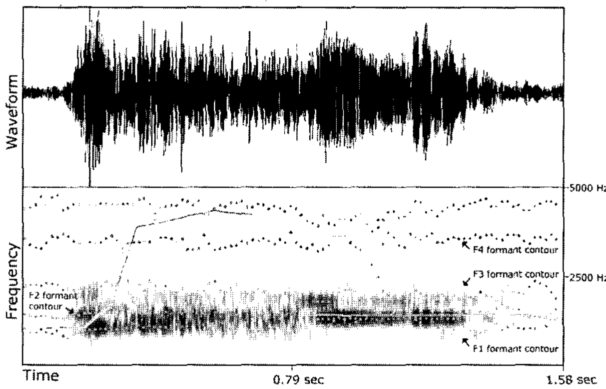


(B) Non-analgesic group

Fig 12. The comparison of spectrogram of moaning between two groups.



(A) Analgesic group



(B) Non-analgesic group

Fig 13. The comparison of spectrogram of screaming between two groups. The dotted line represent formant contour; dark gray band represent large concentration of sound energy in specific time and frequency.

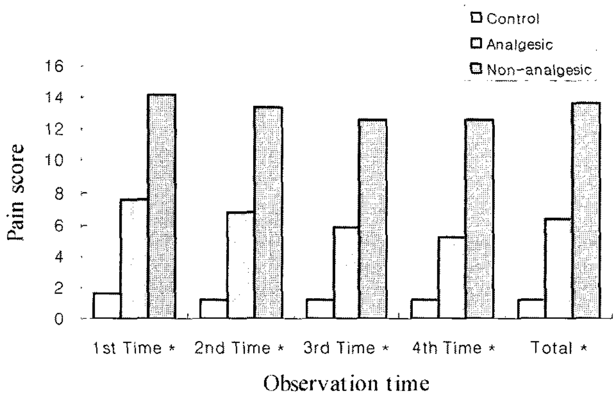


Fig 14. The comparison of pain score between three groups ($p < 0.05$). The dotted line represent formant contour; dark gray band represent large concentration of sound energy in specific time and frequency.

Apart from an immediate protective response like growling and biting when people try to touch their injured legs, animals show diverse and subtle changes in behavior during pain[7,19]. Even if the veterinarian cannot recognize painful situations in animals due to their lack of expression, we cannot say the animal does not feel any pain. Therefore, we can say that it is very important to develop an evaluation method for pain for understanding and evaluation of pain[7]. Many clinical veterinarians are well aware of the fact that pain occurs in the process of their treatments, based on their knowledge of pain. However, if we cannot evaluate pain, we will not be able to deal with it effectively.

Unfortunately, the use of analgesics is restricted due to the lack of appropriate evaluation of the pain of the animals, or due to the preconception or lack of information of the veterinarian themselves about the drug[4,11,15,19,25]. For example, Mathews reported that only 13~26% of the cats and dogs that went through ovariohysterectomy had received analgesics[19]. Considering that veterinarians recommend ovariohysterectomy as a precautionary·measure, such low usage of analgesics shows an inappropriate treatment for animals[7,15].

Most veterinarians think that can recognize pain in animals and try to develop clear standards for pain. Unfortunately, as we have a tendency to personify the acts of the animals, we expect that the animal will respond in the same ways as a human. We may expect that the animals with pain will act in various ways according to the painful area, the degree, and the type of injury. However, we must know that the animal may act differently according to their species, sex, age, and individual differences. Especially, in some species, animals try to hide their pain-related behavior because it may stimulate their predators and make themselves easy prey for predators. Also, young animals have little tolerance for pain. That is, they may exaggerate their pain. Animals might change their response to the pain in familiar and safe environments, so they may show behavior that has little relevance to the pain and also in an unfamiliar environment(e.g. animal hospitals). This is why it is important for veterinarians to investigate their own preconceptions objectively concerning animal behavior that occurs due to pain. Even if the veterinarians are incompetent in recognizing the pain of animals, if they will introduce an objective approach, it will be possible to develop a system that can convert pain into figures. Furthermore, if such investigations are carried out, it will be possible to develop an evaluation method for pain, which can be introduced in clinical treatments[4,6,7,11].

Short reported that the response of animals to pain could be classified into two: the physiological response and the behavioral response[28]. It was reported that there were changes in heartbeat, breath, blood pressure, mydriasis, excessive salivation, serologic values for physiological responses(for example, the increase in blood sugar, Cortizol, ACTH, α-endorphin, and the accumulation of Catecholamine), etc[2,10,17,28]. As for behavioral responses, there were the changes in activity, vocalization (due to pain), facial expressions, body posture, mental state, and appetite[8,12,21,22,28].

Hellyer[14] pointed out that it is easy to figure out the cardiorespiratory in the physiological response when there is pain. However, such physiological responses were effective in evaluating situations that went through anesthesia only, but did not show any difference in the groups that went through operations and the group that did not go through operations. He said it was even less effective in evaluating chronic pain. Also such indices could not show the changes and differences when the animal suffered from anxiety, fear, or disease, such as anemia. Moreover, apart from some responses like the cardiorespiratory function, it is invasive to verify the responses and it takes some time until results are obtained[4,6,7,25].

It is known that the observation of behavioral responses is quite useful in evaluating pain in animals. Because such observations of behavioral responses are non-invasive compared to the physiological ones and immediate evaluation is possible, the method has been noticed by many scientists[1,3,6,14,23]. However, this method also has its defects like the physiological ones. There can be differences in behavioral responses according to age, sex, species, degree of pain, and individual differences[4,6,14,19]. We must make more objective efforts in evaluating the pain of animals in consideration of such points.

The evaluation methods using physiological and behavioral responses of the animals to their pain will contribute much to the prescription of analgesics, treatments, surgical and internal treatments, and diagnosis process, and judgment of the prognosis. The Simple Descriptive Scale(SDS), the Numerical Rating Scale(NRS), and the Visual Analog Scale(VAS) are the methods mainly used these days[4,6,9,11,14,16,19]. The SDS is quite easy to apply but has lower sensitivity, and the NRS that evaluates the vitality has low sensitivity and specificity; it is usually used in evaluating chronic pain. The VAS, which uses a 100 mm ruler, has a relatively higher sensitivity and has been used widely. In 1999, Fifth *et al*[6] carried out a study on post-operational pain in dogs, applying the University of Melbourne Pain Scale(UMPS), which was transformed from the Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) that had originally been created for evaluating post-operational pain in children. The UMPS carries out evaluation on subdivided items from six large categories of physiological responses, response to palpation, mental state, vitality, posture, and vocalization. The UMPS has a relatively higher precision due to the observation under various categories, but was not proved in evaluating pain in cats as it was first developed for evaluation of pain in dogs. It presents a problem in that observation of normal activities must be carried out in advance for evaluation of the mental state[6,14].

In our study, the situations were classified into two; interactive behavior and non-interactive behavior. Interference was excluded in order to avoid the interference that might take place in the process of measuring physiological responses. Therefore, our experiment carried out evaluation on three groups applying only 5 categories among 6 in the UMPS.

The analysis of vocalization in behavioral observation has been rapidly studied in human medicine. The barking of dogs is a part of their way of expressing their intentions. Yeon *et al*[31,32] reported that it is possible to record the voice of the dogs objectively using the spectrogram and it is also possible to utilize it as an important judgment data in figuring out the mental state and the social relationship of the dogs, as well as their relationship with humans. We were also able to verify that it was possible to evaluate the grade of pain, based on the analysis of calls shown by the animals with pain. The existing studies classified the grades of pain based on the presence or absence of pain, and its type and form. As shown in the results of our experiment for the moaning sounds of animals, there were significant differences ($p < 0.05$) in the length and pitch of the call and the 1,2,3,4 Formant comparison measurements that showed the energy intensity of calls between the group that had analgesics and the group that did not.

This experiment was carried out for the establishment of a behavioral observation method for a broader and segmented behavioral observation list. As the result shows, it was identified that the behavioral evaluation method and call analysis were non-invasive for the pain of the animals and it was easier to get faster and easier evaluation results.

Butorphanol used in this experiment is a synthetic opioid that works as a μ-receptor partial agonist and μ, κ-receptor agonist-antagonist. It is known to have little restriction on the cardiorespiratory function in pain-relieving effects and sedation effects. It is reported to be effective in relieving pain of a light and intermediary level, as well as visceral pain. Also, although it was not applied in this study, it can be combined with drugs such as acepromazine and medetomidine for stronger alleviation effects[5,20,26,27,29]. Moreover, recently, the preemptive medication cases that blocked the transmission of pain by applying pain-relievers in the stage of preanesthesia(prenarcosis) have been reported frequently[2]. In the experiment, in the groups that had analgesic treatments, we prescribed analgesics in the stage of preanesthesia(prenarcosis), in order to block the pain caused by intestinal anastomosis under general anesthesia.

Based on the results of this experiment, it can be verified that butorphanol relieved pain after intestinal anastomosis in dogs. However, as the result shows, even in the group that had butorphanol medication, pain-related behavior showed up and pain existed under the UMPS. As various nerve paths and numerous chemical factors cause pain, pain can be relieved by various kinds of pain treatments; for example, the combined use of an analgesic with different working mechanisms.

Conclusion

This study measured the changes in behaviors and voices in dogs after intestinal anastomosis. Based on the results, the findings on the alleviation effect of butorphanol are as follows.

Seventy-five of 100 behavioral observation items were observed in 5 dogs that only had anesthesia (Control group), 5 dogs that went through intestinal anastomosis and had butorphanol treatments (Analgesic group), and 5 dogs that went through intestinal anastomosis but had no analgesic (Non-Analgesic group).

In behavioral observations, low frequency was shown in the group with no analgesic on the behavior such as standing, latent recumbency, no movement when not sleeping in standing position, standing with head up, licking body or the observer, grooming, etc. A high frequency was shown for behavior such as the sitting position, curled-up position, standing with arched back position, standing with head dropped, sitting with arched back, no movement when not sleeping position, screaming, constant screaming, moaning, constant and continuous moaning, and cage biting in the group that had no analgesics.

In the analysis of moaning sounds, the length of the sound showed high in the group with analgesics, and the pitch as well as 1, 2, 3, 4 formant, showed high in the group with no analgesic ($p < 0.05$).

When the observed behavior was applied to the pain scale, the grade of pain showed highest in the group with no analgesics, the group with analgesics, and the group with anesthesia only, in that order, which showed significant differences ($p < 0.05$) among the groups.

In conclusion, the administration of butorphanol was shown to alleviate pain in dogs after intestinal anastomosis and it is considered that the behavioral observation method applied in this study is non-invasive and can be utilized as an effective evaluation method of pain.

Acknowledgements

This work was supported by grant No R05-2001-000-00756-0 from the Basic Research Program of the Korea Science & Engineering Foundation.

References

1. Anil SS, Anil L, Deen J. Challenges of pain assessment in domestic animals. J Am Vet Med Assoc 2002; 220: 313-319.
2. Benson GJ, Grubb TL, Neff-Davis C, Olson WA, Thurmon JC, Lindner DL, Tranquill WJ, Vanio O. Perioperative stress response in the dog: Effect of pre-emptive admini-stration of medetomidine. Vet Surg 2000; 29: 85-91.
3. Conzemius M, Hill CM, Sammarco JL, Perkowski SZ. Correlation between subjective and objective measure used to determine severity of postoperative pain in dogs. J Am Vet Med Assoc 1997; 210: 1619-1622.
4. Dobromylskyj P, Flecknell PA, Lascelles A, Livingston A, Taylor P, Waterman-Pearson A. Pain assessment. In: Pain management in animals, London: WB Saunders. 2000: 53-80.
5. Dobromylskyj P, Flecknell PA, Lascelles A, Pascoe PJ, Taylor P, Waterman-Pearson A. Management of postoperative and other acute pain. In: Pain management in animals, London: WB Saunders. 2000: 81-146.
6. Firth AM, Haldane SL. Development of a scale to evaluate postoperative pain in dogs. J Am Vet Med Assoc 1999; 214: 651-659.
7. Flecknell PA. Animal pain. In: Pain management in animals, London: WB Saunders. 2000: 1-8.
8. Fox SM, Mellor DJ, Stafford KJ, Lowoko CRO, Hodge H. The effects of ovariohysterectomy plus different combinations of halothane anaesthesia and butorphanol analgesia on behaviour in the bitch. Res Vet Sci 2000; 68: 265-274.
9. Grisneaux E, Pibarot P, Dupuis J, Blais D. Comparison of ketoprofen and caprofen administered prior to orthopedic surgery for control of postoperative pain in dogs. J Am Vet Med Assoc 1999; 215: 1105-1110.
10. Hansen BD, Hardie EM, Carroll GS. Physiological measurements after ovariohysterectomy in dogs: what's normal? Appl Anim Behav Sci 1997; 51: 101-109.
11. Hardie EM. Recognition of pain behaviour in animals. In: Animal pain, Janskerkhof: Van Der Wees. 2000: 51-70.
12. Hardie EM, Hansen BD, Carroll GS. Behavior after ovariohysterectomy in the dog: what's normal? Appl Anim Behav Sci 1997; 51: 111-128.
13. Hellebreker LJ. Pain in animals. In: Animal pain, Janskerkhof: Van Der Wees, 2000: 11-16.
14. Hellyer PW. Assessing pain and analgesia. In: Handbook of veterinary pain management, St. Louis: Mosby. 2002: 82-107.
15. Holden D. Postoperative care. In: Manual of small animal anaesthesia and analgesia, Cheltenham: BSAVA. 1999: 15-18.
16. Holton LL, Scott EM, Nolan AM, Reid J, Welsh E, Flaherty D. Comparison of three methods used for assess-

ment of pain dogs. J Am Vet Med Assoc 1998; 212: 61-66.
17. Ko JCH, Mandsager RE, Lange DN, Fox S M. Cardio-respiratory responses and plasma cortisol concentrations in dogs treated with medetomidine before undergoing ovario-hysterectomy. J Am Vet Med Assoc 2000; 217: 509-514.
18. Lamont LA, Tranquilli WJ, Grimm KA. Physiology of pain. Vet Clin North Am Small Anim Pract 2000; 30: 703-728.
19. Mathews KA. Pain assessment and general approach to management. Vet Clin North Am Small Anim Pract 2000; 30: 729-756.
20. Muir ? WW, Ford JL, Karpa GE, Harrison EE, Gadawski JE. Effects of intramuscular administration of low doses of medetomidine and medetomidine-butorphanol in middle- aged and old dogs. J Am Vet Med Assoc 1999; 215: 1116-1120.
21. Noonan GJ, Rand JS, Blackshaw JK, Priest J. Behvioural observations of puppies undergoing tail docking. Appl Anim Behav Sci 1996; 49: 335-342.
22. Noonan GJ, Rand JS, Priest J, Ainscow J, Blackshaw JK. Behavioural observations of piglets undergoing tail docking, teeth clipping and ear notching. Appl Anim Behav Sci 1994; 39: 203-213.
23. Overall KL. Normal canine behavior. In: Clinical behavioral medicine for small animals, St. Louis: Mosby. 1997: 6-76.
24. Pascoe P. Opioid anagesia. Vet Clin North Am Small Anim Pract 2000; 30: 757-772.
25. Pascoe P. Perioperative pain management. Vet Clin North Am Small Anim Pract 2000; 30: 917-932.
26. Pibarot P, Dupuis J, Grisneaux E, Cuvelliez S, Plante J, Beauregard G, Bonneau NH, Bouffard J, Blais D. Comparison of ketoprofen, oximorphone hydrochloride, and butorphanol in the treatment of postoperative pain in dogs. J Am Vet Med Assoc 1997; 211: 438-444.
27. Quandt JE, Rawling CR. Reducing postoperative pain for dogs: local anesthetic and analgesic techniques. Comp Cont Educ Pract Vet 1996; 18: 101-111.
28. Short CE. Fundamentals of pain perception in animals. Appl Anim Behav Sci 1998; 59: 125-133.
29. Thompson SE, Johnson JM. Analgesia in dogs after intercostal thoracotomy a comparison of morphine, selective intercostal nerve block, and interpleural regional analgesia with bupivacaine. Vet Surg 1991; 20: 73-77.
30. Waterman-Pearson A. Analgesia. In: Manual of small animal anaesthesia and analgesia, Cheltenham: BSAVA. 1999: 59-70.
31. Yeon SC, Seo KM, Kweon OK, Nam CC. Common calls of Poodle. Kor J Vet Clin Med 1996; 13: 163-170.
32. Yeon SC, Seo KM, Kweon OK, Nam CC. Spectrographic analysis of the sound after vocal cordectomy in dogs. Kor J Vet Clin Med 1997; 14: 48-55.

Butorphanol의 투여가 장문합술 후 개의 행동에 미치는 영향

구자민 · 이희천 · 장홍희 · 성용증 · 이효종 · 연성찬[1]

경상대학교 수의과대학 동물의학 연구소

요 약 : 본 연구는 개에서 장문합술 후 비침습적인 행동관찰을 통해 통증을 평가하기 위하여 수행되었으며, 또한 이를 토대로 butorphanol의 진통효과에 대해 연구하였다. 본 실험에서 대조군은 마취를 실시하였으나 장문합술은 시행되지 않았다. 진통제 투여군의 5마리 개들에게는 장문합술을 실시하였고 butorphanol을 투여하였다. 진통제 비투여군의 5마리 개들에게는 진통제 투여 없이 장문합술을 실시하였다. 진통제 투여군의 개들은 수술 전 그리고 수술직후 butorphanol(0.4 mg/kg, IM)이 투여되었고, 반면에 대조군과 진통제를 투여하지 않은 군에서는 동일한 양의 멸균 생리식염수가 투여되었다. 개의 행동은 마취 후 400분 동안 비디오테이프로 기록되었고, 그 시간에 실험자는 매 80분마다 개와 상호작용을 하였다. 각각의 상호작용에서, 실험자는 관찰된 행동을 바탕으로 멜버른 대학의 통증 측정방법을 이용하여 통증 점수를 기록하였다. 한 사람의 관찰자에 의해 정량화 된 상호작용과 비 상호작용의 행동을 측정하기 위하여 한 개체에 집중하는 연속적 표본 추출 방법이 적용되었다. 발성은 마취 후 400분 동안 녹음하였고 소리 길이, 소리 강도, 소리 pitch와 1-4 포먼트를 분석하였다. 외과수술은 통증측정 점수를 증가시켰다. 실험자와의 상호작용 중에서 수술 후 인사하는 행동이 감소되었다. 진통제를 투여한 수술군과 위약을 투여한 군사이의 차이점은 정량화된 행동 측정과 발성을 통하여 구별할 수 있었다. Butorphanol을 투여한 수술군과 위약을 투여한 군 사이에는 유의적인 차이를 관찰할 수 있었다 ($p < 0.05$).

주요어 : 개, 장문합 수술, 행동, butorphanol