Application of Zolazepam-HCl and Tiletamine-HCl to Immobilization of Hokkaido Brown Bear (*Ursus arctos yessoensis*)

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(1998.7.27 received, 1999.1.20 accepted)

エゾヒグマ (*Ursus arctos yessoensis*) の不動化に対する 塩酸ゾラゼパムと塩酸チレタミンの応用

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ABSTRACT. Twenty captive and 9 wild bears were treated with a mixture of zolazepam-HCl and tiletamine-HCl to evaluate effective dosages for immobilization and physiological responses of immobilized bears. Total dose required for effective immobilization were small (3.52 ± 1.53 mg/kg in captive, and 3.75 ± 1.57 mg/kg for wild bears), and immobilized bears showed good muscle relaxation and smooth recovery. Accordingly, this mixture of zolazepam-HCl and tiletamine-HCl was considered effective for the immobilization of Hokkaido brown bears.

Key Words : brown bear, tiletamine-HCl, zolazepam-HCl

Jpn. J. Zoo Wildl. Med. 4(1) : 61-64, 1999

A combination of xylazine hydrochloride (xylazine-HCl) and ketamine hydrochloride (ketamine-HCl) has been used to immobilize a number of bear species, including the Hokkaido brown bear (*Ursus arctos yessoensis*) [1,5,10]. Although this combination has the advantage of a wide dosage tolerance, the recovery of immobilized animals is slow, and a

large volume of drug is needed to immobilize large animals. In addition, at concentrations above 250 mg/ml, the solution including ketamine-HCl must be kept warm to avoid crystallization of ketamine-HCl, making it difficult to use in cold weather conditions [6].

A combination of zolazepam hydrochloride (zolaze-

Table 1. Drug dosages and physiological responses of captive and wild bears

Dosage and response	Captive bears (No. of bears)	Wild bears (No. of bears)
Body weight(kg)	263.7 ± 104.9 (20)	61.6 ± 27.7 (9)
Induction dose(mg/kg)	3.52 ± 1.53 (20)	3.75 ± 1.57 (9)
Volume(ml/kg)	0.035 ± 0.015 (20)	0.037 ± 0.016 (9)
Induction time(min.)	14.4 ± 10.5 (14)	13.2 ± 10.3 (9)
Rectal temp.(°C)	37.1 ± 0.5 (6)	37.9 ± 0.3 (8)
Respiration rate(/min.)	16.1 ± 11.9 (11)	15.6 ± 1.8 (9)
Heart rate(/min.)	89.0 ± 14.4 (4)	118.3 ± 20.1 (7)
Total dose(mg/kg)	3.81 ± 1.56 (20)	4.69 ± 1.70 (9)
Handling time(min.)	NC ^{*1}	35.4 ± 14.4 (9)

^{*1}NC : Not clocked.

pam-HCl) and tiletamine hydrochloride (tiletamine-HCl) is now commonly used to immobilize the American black bear (*Ursus americanus*), the grizzly bear (*Ursus arctos horribilis*) and other wild animals [2,4,8,9]. One of the key benefits of this combination is the small volume of drug necessary for immobilization [8]. In this study, we evaluated dosages necessary for immobilization, and physiological responses of captive and wild Hokkaido brown bears to a mixture of zolazepam-HCl and tiletamine-HCl.

Twenty bears kept in Noboribetsu bear park and 9 wild bears captured in south western Hokkaido were immobilized with a 1:1 mixture of zolazepam-HCl and tiletamine-HCl (Zolatil 100, Virbac, France: mixture of 250 mg zolazepam-HCl and 250 mg tiletamine-HCl). After injection of atropin sulfate (0.5 mg/head or 0.5 mg/100 kg for larger individuals; Atropin sulfate, Tanabe, Japan) by a syringe or a blow gun, 3 mg/kg of zolazepam-HCl and tiletamine-HCl (prepared at 100 mg/ml) were also injected by a syringe or a blow gun based on measured (captive) or estimated (wild) body weight. After confirmation of induction, body size and weight were measured, radio-transmitter and ear tags were attached, blood samples were collected, and a tooth was extracted for age determination for wild bears. For captive bears, only blood samples were taken. Times from first injection of zolazepam-HCl/

tiletamine-HCl mixture to induction (defined as the time that a bear laid down its head, became sternally recumbent, and showed no response to a loud noise) were measured, and subsequent respiration rates, heart rates and rectal temperatures were recorded at approximately 19(18.6±6.4), 25(25.1±8.1) and 16(16.1±5.9) minutes from induction respectively. In some captive bears, time to recovery (defined as the time that a bear stands up and can walk) was noted, but this was not measured in wild bears to minimize danger to the handlers. If immobilized bears showed any signs of recovery during the handling, 1/3 to 1/2 volumes of the initial dose were administered by hand injection.

Table 1 summarizes data collected on dosages administered and physiological responses in both captive and wild bears. Because only blood samples were collected from most captive bears, handling time was very short and is not recorded. Immobilized bears exhibited relaxed muscles and were easy to handle. When compared with the administration of xylazine-HCl and ketamine-HCl (0.96±0.12 mg/kg of xylazine-HCl and 8.76±3.42 mg/kg of ketamine-HCl, unpublished personal data on 23 captive bears), a significantly lower dose of the zolazepam-HCl/ tiletamine-HCl mixture was necessary for complete immobilization ($P < 0.01$, Mann-Whitney's U-test). In addition, since both zolazepam-HCl and tiletamine-HCl are highly water-soluble, the mixture

Immobilization of Hokkaido Brown Bear

Table 2. Recovery time of captive bears.

Bear	Sex	Time to Recovery(min.)		
		First inj.	Induction	Last inj.
1	male	56	35	20
2	male	82	74	40
3	male	51	41	— ^{*2}
4	male	45	40	—
5	female	59	55	—
6	male	66	NC ^{*1}	—
7	male	57	NC	—
Mean±SD		59±12	49±16	30±14

^{*1}NC : Not clocked. ^{*2}— : Additional injection was not administered.

can be used in higher concentrations (maximum 500 mg/ml) so that small darts can still be used on larger animals [8]. Zolazepam-HCl/ tiletamine-HCl mixture apparently does not crystallize in cold weather conditions as easily as does ketamine-HCl [5]. Respiration rate was thought to reflect the depth of immobilization better than other indices in this study, with rates of 10 to 20 breaths per minute considered to represent a safe range for handling immobilized bears. Further study is necessary to clarify the relationship between respiration rate and depth of immobilization using zolazepam-HCl and tiletamine-HCl. Heart rates appeared to be higher than those recorded for the administration of xylazine-HCl and ketamine-HCl (59.2 ± 13.1 , unpublished personal data on 23 captive bears), but limited sample size precludes statistical analysis. This difference in average heart rates may reflect the bradycardia associated with xylazine-HCl [6].

The recovery times for 7 captive bears measured from first injection of zolazepam-HCl/ tiletamine-HCl mixture, induction, and last injection are shown in Table 2. As reported for the grizzly bear, recovery phases were smooth and mimicked in reverse order (but more slowly) the signs observed during induction [9]. The recovery times measured from first injection and induction ranged from 56 to 82 minutes and from 35 to 74 minutes, respectively.

Rapid recovery from immobilization is recognized as an important consideration for animal safety, particularly when others may prey on an immobilized or slowly recovering animal. Thus, yohimbine hydrochloride is recommended as an effective antagonist to ketamine-HCl and xylazine-HCl for polar bears and black bears [3,7]. However, in Hokkaido, access to trapping sites can only be made on foot, so adequate time for handlers to leave the area before the bear recovers is a prior consideration. As shown in Table 2, the recovery time from first injection seems short enough to ensure bear safety while allowing handlers enough time to leave the area safely.

We conclude that the combination of tiletamine-HCl and zolazepam-HCl is safe and effective for immobilizing Hokkaido brown bears.

要 約

飼育下 20 頭および野生 9 頭のエゾヒグマを対象に、塩酸ゾラゼパムと塩酸チレタミンの混合薬の効果と有効量を検討した。その結果、不動化に必要な薬用量は飼育個体で 3.52 ± 1.53 、野生個体では 3.75 ± 1.57 mg/kg と十分に少量であった。また、不動化されたクマは十分に脱力しており、飼育個体については覚醒も速やかであった。エゾヒグマに対してこの薬物の組み合わせが有効であることが示唆された。

キーワード：ヒグマ、塩酸チレタミン、塩酸ゾラゼパム

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