Immobilization of the Free-Ranging Hokkaido Brown Bear, Ursus arctos yesoensis with Ketamine Hydrochloride and Xylazine Hydrochloride
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We immobilize free-ranging animals by using drugs in order to attach a radio transmitter or to collect various materials from their bodies. When large mammals such as bears are immobilized by drugs, the handler's safety as well as animal's should be considered. The use of ketamine hydrochloride (KH) and xylazine hydrochloride (XH) can induce a good anesthesia because of sufficient analgesia through KH and amplified tractability and myorelaxation through XH. Although anesthesia by the combination of KH and XH has some limitations such as difficulty in deflation, it has been widely used to immobilize many free-ranging mammalian species such as black bears [1], polar bears [8], Japanese monkeys [4], mule deer [6], coyotes [7] and African lions [5] due to the advantage of a single injection.

To date, no report has been published on the immobilization of free-ranging Hokkaido brown bears. The objective of this study is to examine the combination of KH and XH as a method to immobilize free-ranging Hokkaido brown bears.

Twelve free-ranging Hokkaido brown bears (7 males and 5 females) were used in this study. Age and weight ranged from 1 to 14 years, and from 40 to 165 kg, respectively. They were captured by barrel traps [9] from May 1987 to October 1988 in Oshima and Shiretoko Peninsula, Hokkaido and immobilized 13 times with drugs. The combination of 10 mg/kg KH (Ketalar, Sankyo-Parke-Davis & Co., Inc., Japan) and 1 mg/kg XH (Celanectar, Bayer, West Germany) was used as the anesthetic for immobilization of the brown bears. Atropine sulfate (AS; Atropine, Tanabe, Japan) at a dose rate of 0.03 mg/kg was administered as a premedication. Each dose was calculated based on estimated body weight. These drugs were injected intramuscularly with a metallic poke stick or polyethylene disposable syringe. When the bears were not effectively immobilized with the initial injection, or if bears recovered from the anesthetized phase during handling, additional injections of KH were given. After induction into an anesthetized phase, handling such as the attachment of a radio-transmitter and an ear tag, the measurement of body weight and length, tooth extraction for age determination, blood and scat sampling, and reproductive examination was carried out. We paid attention to their postures and physical condition by monitoring body temperature and heart rate during handling.

Induction time was the period from injection to the time that the bear became tractable, when it had lost muscle control of its legs, head and jaws. Recovery time was not determined because of time constraints and potential danger to the handler.

Statistical differences in induction times and dosages, and total dosages between the sexes were determined by Student's t test.

Induction dosages and times, rectal temperatures, total dosages and handling times are shown in Table 1. Doses of 0.012-0.040 mg/kg (Mean = 0.028 mg/kg) AS, 6.8-33.3 mg/kg (Mean = 15.4 mg/kg) KH and 0.4-1.4 mg/kg (Mean = 1.0 mg/kg) XH were administered for induction into the anesthetized phase. The induction time ranged from 4 to 82 min (Mean = 24 min). Each dosage and time varied among individuals. Particularly in some bears, higher drug dosages and longer induction time seemed to be performed in comparison with their body weight. Rectal temperatures after administration of KH and XH were between 37.5°C and 41.3°C (Mean = 38.6°C). Heart rate after administration of KH and XH were 64, 66 and 76 beat/min in 3 bears. Total dose of 9.2-33.3 mg/kg (Mean = 20.3 mg/kg) KH which was administered by repeated injections, and 0.4-1.4 mg/kg (Mean = 1.0 mg/kg) XH were required for handling. The handling time ranged from 20 to 47 min (Mean = 30 min). Induction dosage and time, total dosage and handling time were not significantly different between the sexes (p> 0.05).

This is the first report regarding successful immobilization of free-ranging Hokkaido brown bears as far as we know. Immobilization with the combination of KH and XH appears to be useful for Hokkaido brown bears. The combination of KH and XH was superior with respect to its smooth induction, good myorelaxation, slight quivering, and wide margin of safety. Although we did not observe the recovery phase in our study, Addison and Kolenosky [1] reported that the return of coordination was gradual in black bears (Ursus americanus). It is considered that the use of AS as a premedication also made the induction smooth through its preventive actions against salivary secretion, vomiting, reduction of blood pressure, bradycardia and cardiac arrest. Actually, we hardly observed the salivary secretion during handling. Rectal temperatures ranged from 37.5°C to 41.3°C in 12 brown bears, similar to the findings in polar bears (Ursus maritimus) by Lee et al. [8], which were evaluated as
Table 1. Information on intramuscular administrations of atropine sulfate (AS), ketamine hydrochloride (KH) and xylazine hydrochloride (XH) in Hokkaido brown bears

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample size</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Age (year)</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>8</td>
<td>101</td>
<td>38</td>
</tr>
<tr>
<td>Induction dosage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AS (mg/kg)</td>
<td>6</td>
<td>0.028</td>
<td>0.006</td>
</tr>
<tr>
<td>KH (mg/kg)</td>
<td>8</td>
<td>13.9</td>
<td>5.7</td>
</tr>
<tr>
<td>XH (mg/kg)</td>
<td>7</td>
<td>0.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Induction time (min)</td>
<td>8</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Rectal temperature (°C)</td>
<td>8</td>
<td>38.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Total dosage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KH (mg/kg)</td>
<td>8</td>
<td>17.8</td>
<td>6.1</td>
</tr>
<tr>
<td>Handling time (min)</td>
<td>8</td>
<td>30</td>
<td>8</td>
</tr>
</tbody>
</table>

a) A combination of KH and XH was administered for the induction of anesthesia.
b) Additional injections of KH were given.
c) Handling such as the attachment of a radio-transmitter and an ear tag, measurement of body weight and length, tooth extraction for age determination, blood and scat sampling, and reproductive examination.

overheating. It is considered that the 12 brown bears in our study might be overheated in comparison to the resting temperature of 36.9°C for bears [2]. However, overheating did not appear to affect immobilization with the combination of KH and XH in brown bears.

The combination of KH and XH has been used for smooth induction into anesthesia in other Ursidae. In American black bears, single intramuscular injections of 1.5–17.1 mg/kg of KH combined in an approximate ratio of 2:1 with 0.9–10.0 mg/kg of XH immobilized bears for 1.5–19.7 min [1]. Administration of 3.3–10.6 mg/kg of both KH and XH also resulted in a mean induction time of 13.2 min in polar bears [8]. In Hokkaido brown bears, however, the dosage of XH and KH necessary for induction into the anesthetized phase was lower and higher than the above dosages, respectively.

The handling time of approximately 30 min was completed with a single injection of KH-XH in one brown bear and with 2 or more injections in the others. It was determined in a previous study (Tsubota et al., unpublished) that the optimum dosages of KH and XH to immobilize captive brown bears for handling were 10 mg and 1 mg per kg of body weight, respectively. Since these criteria were adopted for free-ranging brown bears in this study, higher actual dosages were used. It is thought that this disparity between captive and free-ranging brown bears is due to differences in sensitivity to anesthetics and stress associated with their capture by traps. Higher initial dosages are needed to immobilize brown bears for handling.

Although induction dosages and times, total dosage and handling time were not significantly different between the sexes, we recommend that bigger sample sizes should be used for further study.

Although data on recovery time were not determined, we believe that bears recover smoothly from the anesthetized phase. The use of an antagonist to the anesthetic is considered to enhance smooth recovery. Yohimbine hydrochloride has been effectively used as an antagonist to KH-XH immobilization in black [3] and polar bears [10]. However, the use of an antagonist should be tested with respect to the handler’s safety as well as to its effects on brown bears.

REFERENCES