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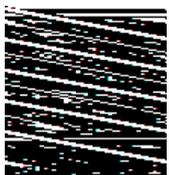
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Immobilization of wolverines with Telazol[®] from a helicopter

Howard N. Golden, Brad S. Shults, and Kyran E. Kunkel

Abstract Chemical immobilization of wildlife from a helicopter requires use of a drug dose that is adequate to sufficiently anesthetize an animal for handling, and a potent but safe drug is preferred. We assessed effectiveness of Telazol[®] to immobilize free-ranging wolverines (*Gulo gulo*) by darting them with a standard dose of 175 mg from a helicopter in Alaska, 1992–1999. Induction occurred in 3.7 ± 0.3 minutes, with no difference between genders ($\chi^2_1 = 1.35$, $P = 0.245$) despite dimorphism in body mass. Initial sedation was 47.1 ± 9.6 minutes and was usually sufficient for handling, but approximately 33% of the wolverines required additional doses of 50–100 mg to maintain sedation. Initial sedation and recovery (95.5 ± 11.2 minutes) were related positively to dosage (mg/kg, $r = 0.76$, $P < 0.004$ and $r = 0.90$, $P < 0.001$, respectively). We conclude that Telazol is an effective and safe drug to immobilize wolverines from a helicopter. We recommend projecting it as a standard dose in a small dart at low power to minimize injury and then supplementing as needed to maintain sedation.

Key words anesthesia, *Gulo gulo*, handling, helicopter darting, immobilization, Telazol, tiletamine, wolverine, zolazepam

Telazol[®] (Fort Dodge Laboratories, Inc., Fort Dodge, Ia., USA) is used widely as an immobilizing agent for wildlife (Schobert 1987). It has been used in field situations to immobilize mustelids such as American martens (*Martes americana*, Bull et al. 1996), striped skunks (*Mephitis mephitis*, Lariviere and Messier 1996), river otters (*Lontra canadensis*, Blundell et al. 1999), and fishers (*Martes pennsylvanica*, Mitchell et al. 1999). It also has been used successfully on wolverines (*Gulo gulo*) in zoos (Petrini 1992).

Wolverines in the field have been immobilized in live traps with the cyclohexanone derivative ketamine hydrochloride (HCl), either alone (Hash and Hornocker 1980, Magoun 1985, Landa et al. 1998) or in a mixture with the α_2 -adrenergic agonists xylazine HCl (Banci 1987, Copeland 1996) or

medetomidine HCl (Landa et al. 1998). Ballard et al. (1982) used the opioid etorphine HCl on a wolverine in a live trap and used a mixture of etorphine HCl and xylazine HCl to capture wolverines from a helicopter. Phencyclidine HCl, another cyclohexanone derivative, also was used in a mixture with xylazine HCl to capture wolverines from a helicopter (Gardner 1985, Magoun 1985). Phencyclidine HCl is no longer available in the United States (Nielsen 1999), but ketamine HCl and etorphine HCl are fast acting and have resulted in satisfactory immobilizations in field studies, especially when used in combination with α_2 -adrenergic agonists.

Chemical immobilization of wildlife from a helicopter requires use of a drug dose (mg) that is adequate to sufficiently anesthetize an animal for handling. A potent but safe drug is preferred, especially

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when body size and therefore dosage (mg/kg) may vary widely, as with wolverines. Despite their effectiveness as anesthetics used in capturing small animals, ketamine HCl and etorphine HCl have disadvantages. The relatively low potency of ketamine HCl requires sizable doses for immobilization even when mixed with tranquilizers, whereas the main disadvantages of etorphine HCl are respiratory depression in the immobilized animal and its extreme toxicity to humans (Nielsen 1999).

Telazol is a nonopioid, nonbarbiturate anesthetic comprising equal portions of tiletamine HCl, a cyclohexanone dissociative anesthetic, and zolazepam HCl, a diazepamone tranquilizer. Immobilization with Telazol is characterized by rapid induction, cataleptoid anesthesia, profound analgesia, good muscle relaxation, retention of laryngeal and pharyngeal reflexes, and smooth recovery (Schobert 1987, Nielsen 1999). Its effectiveness in immobilizing animals from a helicopter was evaluated for brown bears (*Ursus arctos*, Taylor et al. 1989) and wolves (*Canis lupus*, Ballard et al. 1991) with positive results. Our objective was to assess Telazol's effectiveness in immobilizing free-ranging wolverines from a helicopter.

Study area

We conducted this study in the eastern Talkeetna Mountains in south-central Alaska (62°30'N, 147°30'W) and in the Baird Mountains in north-western Alaska (68°00'N, 158°00'W). Elevations in the Talkeetna Mountains study area were higher (760–2,360 m) than in the Baird Mountains (300–1,450 m). Both areas were characterized by slopes and ridges dominated by alpine tundra vegetation and dissected by lowlands and drainages sparsely covered with spruce-hardwood forest. The study areas were roadless, but had snow-machine trails used for recreation and trapping. During capture periods (January–April) temperatures ranged from -40°C to 0°C and snow depths averaged 0.5–1 m.

Methods

We captured wolverines in the eastern Talkeetna Mountains during April 1992–March 1997 and in the Baird Mountains during February–March 1999. Captures were usually within 24–72 hours after a fresh snowfall of >5 cm and when ambient temperatures were >-25°C. With a helicopter standing

by, we located wolverines by searching the study areas for their tracks from fixed-wing aircraft. When we found a wolverine that was >100 m from an escape route such as a hole, rock outcrop, or boulder field, we used the helicopter to approach the animal to within darting range (approximately 5–15 m). Chase times were usually <10 minutes to minimize stress. We darted each animal with a standard dose of 175 mg of Telazol, which had been reconstituted from powder with sterile water in 500-mg vials to achieve a concentration of 100 mg/ml. The standard dose was set to immobilize a 13.5-kg animal at a dosage of 13 mg/kg. We used the Cap-Chur® projectile system (Palmer Cap-Chur Equipment, Inc., Douglasville, Ga., USA) to deliver 2-ml aluminum darts fitted with 2-cm barbed needles and shot them from the extra long-range projector with the least-powered (brown powder) charges. We kept darts warm with chemical handwarmers or the heater vent on the helicopter to prevent freezing. We attempted to dart wolverines in the rump or thigh to achieve complete intramuscular injection, and avoided shots that risked penetrating the thoracic or abdominal walls. After a wolverine was darted, we stopped pursuit, landed the helicopter, and monitored the animal with fixed-wing aircraft until immobilization took effect. We only considered animals immobilized by a full injection of Telazol from a single dart in our analyses.

We processed immobilized wolverines in the field to record their gender, weight, body measurements, and condition. We extracted and preserved blood, hair, skin tissue, and a small premolar (for aging), and we examined mammary glands of



Wolverines located >100 m from escape terrain were pursued by helicopter for darting with Telazol. Photo by Jeff Cain.

Table 1. Immobilization statistics for wolverines captured with Telazol by darting from a helicopter in the Talkeetna Mountains and Baird Mountains, Alaska, 1992-1999.

Statistic	Females				Males				Total			
	n	\bar{x}	SE	Range	n	\bar{x}	SE	Range	n	\bar{x}	SE	Range
Mass (kg)	11	10.7	0.3	9.1-12.6	24	14.5	0.3	11.2-18.0	35	13.3	0.4	9.1-18.0
Initial dosage (mg/kg)	11	16.6	0.5	13.9-19.2	24	12.2	0.3	9.7-15.6	35	13.6	0.4	9.7-19.2
Total dosage (mg/kg)	4	16.3	0.7	15.1-17.5	6	14.6	1.3	11.7-18.6	10	15.3	0.8	11.7-18.6
Induction time (min)	11	3.1	0.3	2.0-4.0	24	4.0	0.4	1.3-10.0	35	3.7	0.3	1.3-10.0
Initial sedation time (min)	2	92.5	18.5	74.0-111.0	10	38.0	8.6	7.0-86.5	12	47.1	9.6	7.0-111.0
Recovery time (min)	4	98.5	7.8	78.0-111.0	6	93.5	18.7	49.0-172.0	10	95.5	11.2	49.0-172.0

females for evidence of current or previous lactation. We then attached a radio collar and ear tags to each animal. We monitored respiration and body temperature, and animals with elevated temperatures ($>39^{\circ}\text{C}$) were cooled with snow. We administered an ophthalmic ointment and treated any lesions from darting or other recent, superficial wounds with antibiotic ointments. We placed processed animals on their sides, with their heads pointed slightly down and free of any obstructions that could hinder breathing, and left them undisturbed to recover from the effects of Telazol. We attempted to monitor their recovery either by remaining nearby or by checking on them from the fixed-wing aircraft until they were ambulatory (i.e., able to walk without falling over). We placed wolverines exposed to ambient temperatures of less than -30°C for more than 1 hour in sleeping bags during recovery to minimize their risk of hypothermia or frostbite. We captured and handled all wolverines in accordance with the Animal Welfare Policy of the Alaska Department of Fish and Game.

We measured induction as the time between successful darting and when the wolverine was recumbent and approachable. Initial sedation was the time between induction and when an additional injection of Telazol was needed to prolong anesthesia during handling. Recovery was the entire period of immobilization from induction, including subsequent injections of Telazol, until the wolverine was ambulatory. We measured induction for wolverines from the Talkeetna Mountains and Baird Mountains study areas, but we measured initial sedation and recovery only for animals caught in the Talkeetna Mountains. We tested differences in dosages and immobilization periods by gender and changes in body temperature before and after the first 30 minutes following darting with Kruskal-Wallis rank sum tests (Zar 1999). We explored rela-

tionships between dosage and immobilization periods with correlation analyses based on Pearson's statistics (Zar 1999).

Results

We captured 29 individual wolverines (9 F, 20 M) and recaptured 2 females and 4 males for a total of 35 captures during the study. We used approximately 2 darts per wolverine for each successful dart strike, 77% of which were placed in the rump, upper flank, or thigh. The remaining 23% of successful dart strikes were in the midback, shoulder, neck, and tail.

Under the standard dose of Telazol used during captures, sexual dimorphism in body mass resulted in higher initial dosages for females than for males ($\chi^2_1 = 19.40$, $P < 0.001$, Table 1). However, induction did not differ between genders ($\chi^2_1 = 1.35$, $P = 0.245$, Table 1), and there was no clear relationship between induction and initial dosage ($r = -0.33$, $t_{3,3} = 1.97$, $P = 0.057$). All but 2 wolverines were induced within 6 minutes. Outliers at 9 minutes and 10 minutes may have resulted from poor absorption of the drug even though the darts struck the hindquarters, which should have been well vascularized (Nielsen 1999).

Approximately 33% of wolverines captured required additional injections of Telazol to complete handling. We hand-injected 10 males and 2 females with a second dose of 50-100 mg between 7 and 111 minutes following induction (Table 1). Two males required a third injection, one at 15 minutes and one at 45 minutes after the second injection (which followed induction by 7 minutes and 21 minutes, respectively). We observed no adverse effects from subsequent injections. Initial sedation was nearly 2.5 times longer for females than for males (Table 1), although this difference was not significant ($\chi^2_1 = 3.75$, $P = 0.053$), and initial sedation

was related positively to initial dosage ($r=0.76$, $t_{100}=3.74$, $P<0.004$). Ten wolverines took 49 to 172 minutes to recover following induction (Table 1). None of the 4 females required additional injections of Telazol to prolong sedation, but 4 of the 6 males did. There was no difference between genders in total dosage ($\chi^2_1=0.74$, $P=0.391$) or recovery ($\chi^2_1=0.41$, $P=0.522$), but recovery was related positively to total dosage ($r=0.90$, $t_8=5.86$, $P<0.001$).

We observed no unusual behaviors or adverse side effects among captured wolverines that could be attributed to Telazol. After darting, the wolverines first lost motor control of their hind legs, followed by their forelegs, and then their heads and necks. At induction they were usually in ventral or lateral recumbency, their eyes were open, and they had no apparent anxiety. During anesthesia respiration rate was slow, regular, and somewhat shallow, but not depressed. Wolverines would occasionally take a deep breath and sneeze or cough in response to excessive salivation, probably induced by the drug (Nielsen 1999). Body temperature was moderately elevated shortly after darting, but thermoregulation was not a problem. Temperatures of captured wolverines varied from 37.3°C to 41.3°C ($\bar{x}=39.4^\circ\text{C}$, $\text{SE}=0.32$, $n=11$) during the first 30 minutes after darting, but then dropped to between 36.0°C and 39.0°C ($\bar{x}=37.8^\circ\text{C}$, $\text{SE}=0.49$, $n=6$) within 41–77 minutes after darting ($\chi^2_1=7.11$, $P<0.008$). Indications the drug effects were wearing off were head bobbing, muscle tetany, and pronounced limb twitching. During the latter stages of recovery, wolverines regained motor control in reverse sequence of induction.

Discussion

The standard initial dosage of Telazol we used (13 mg/kg) was at least twice the 3.5–6.5 mg/kg used to immobilize wolverines in zoos (Petrini 1992), but it was lower than the 14.3–15.8 mg/kg suggested by the manufacturer for surgery in cats (Fort Dodge Laboratories, Inc., Fort Dodge, Ia., USA). The maximum safe dosage of Telazol, including initial and supplemental injections, is 30 mg/kg for dogs and 7.2 mg/kg for cats. Initial and total dosages for captured wolverines in our study ranged between 9.7 and 19.2 mg/kg and were within the tolerances allowed by Telazol. This ensured rapid induction after darting from a helicopter and suitable sedation time for our procedures.

Our initial dose of 175 mg allowed us to project Telazol in a 2-ml dart with the least-powered charge, which reduced risk of injury from the dart's impact. This is an important attribute that compares favorably with other immobilizing drugs used on wolverines. For example, although ketamine HCl also is a cyclohexanone derivative, it is 3–4 times less potent than tiletamine HCl (Nielsen 1999). Copeland (1996) used a hand-injected mixture of 100 mg ketamine HCl (100 mg/ml) and 20 mg xylazine HCl (100 mg/ml) per 4.5 kg body weight to immobilize live-trapped wolverines. This would require a standard dose of 360 mg (3.6 ml) to immobilize a 13.5-kg wolverine, which would necessitate using a 4-ml dart from a helicopter. Darting-related injuries would probably increase with the larger dart and rapid injection of more fluid into muscle tissue.

Sedation was reported to be approximately 3 times longer by Telazol than by ketamine HCl (Nielsen 1999). The relatively long sedation allowed us to complete handling of most wolverines within 45 minutes without additional injections. After that amount of time, some of the more invasive procedures, such as drawing blood or pulling a small premolar, were more difficult to accomplish with only one dose because the animals began to recover. Our data indicated that the greater body mass of males and their consequent lower initial dosage was responsible for more of them needing subsequent injections than did females. This relationship also was observed in fishers immobilized with Telazol, ketamine HCl, or a mixture of ketamine HCl and xylazine HCl (Mitchell-tree et al. 1999). We also had to prolong anesthesia



Wolverines recovered from the effects of Telazol by regaining motor control first of their heads and necks, followed by their forelegs, and then their hind legs. Photo by Jeff Cain.

when we captured ≥ 2 wolverines in rapid succession and processed them simultaneously. We observed a positive relationship between dosage and duration of immobilization. Under extreme cold, lengthy recovery was a disadvantage, but this can be avoided by placing recovering wolverines in sleeping bags.

We conclude that Telazol is an effective and safe drug to immobilize free-ranging wolverines from a helicopter. At an initial dose of 175 mg, it induced rapid anesthesia in all wolverines and provided a safe handling time and a smooth recovery despite the size difference between genders. We recommend using this standard dose to capture wolverines and then supplementing with smaller doses of 50–100 mg as needed to maintain sedation. Varying the initial dosage of an immobilizing agent may be appropriate when body mass can be estimated, but we do not believe this is possible for wolverines during captures by helicopter. Furthermore, the longer initial sedation that would result from higher doses (primarily for males) probably would not outweigh the increased risk of injury from injecting more drug with a larger dart. Capturing by darting from a helicopter is inherently more risky to animals and to capture teams than live-trapping, but it is often the most practical method. We strongly recommend using helicopter pilots and darters who are skilled at animal capture to minimize pursuit time and fatigue to the animal and to maximize safe dart placement and appropriate drug injection. In addition, we believe it is essential to conduct captures by helicopter with the assistance of fixed-wing aircraft to efficiently locate available wolverines and then to monitor those animals immediately after darting and during recovery.

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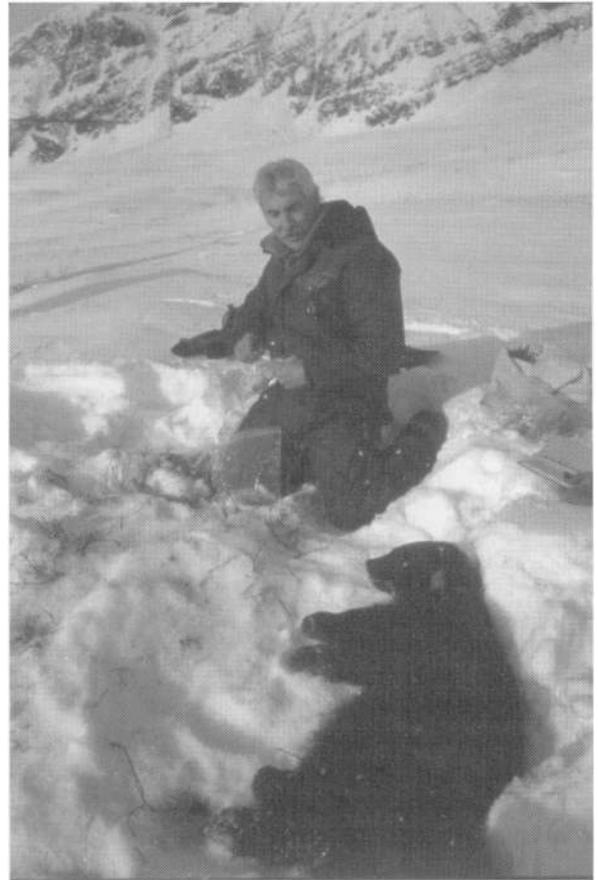


Photo by Mark Masteller.