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Antagonism of Xylazine in White-Tailed Deer with Intramuscular Injection of Yohimbine

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ABSTRACT: Eighteen free-ranging white-tailed deer (*Odocoileus virginianus*) were captured near Chestertown, Maryland (USA) from 15 February to 21 March, and 7 October to 13 November 1986. Deer were immobilized by intramuscular injection of 1.1 to 2.2 mg/kg xylazine hydrochloride and 1.8 to 4.4 mg/kg ketamine hydrochloride. Four captive deer from The Pennsylvania State University, Pennsylvania (USA), were immobilized on 16 September 1986 with 1.5 to 2.0 mg/kg xylazine hydrochloride. Intramuscular injection of yohimbine hydrochloride (0.4 mg/kg) was used to antagonize the immobilizations. Free-ranging adult (≥17 months) males could stand after a mean (±SE) time of 7.3 ± 2.4 min, adult females after 8.6 ± 1.7 min, male fawns after 5.7 ± 3.3 min, and female fawns after 8.9 ± 1.9 min. Captive adult males could stand after 20.2 ± 3.4 min. Intramuscular injections of yohimbine hydrochloride effectively and safely antagonized the xylazine hydrochloride in immobilized deer and were easier to administer than intravenous injections.

Key words: Antagonist, immobilization, intramuscular injection, white-tailed deer, xylazine hydrochloride, yohimbine hydrochloride, *Odocoileus virginianus*.

Chemical immobilization of white-tailed deer (*Odocoileus virginianus*) may be necessary for many research studies. Xylazine and xylazine-ketamine mixtures commonly have been used to immobilize captive white-tailed deer (Gibson et al., 1982; Mech et al., 1985). These drugs, especially xylazine, can result in immobilization times of up to 6 hr (Hsu and Shulaw, 1984). Extended immobilization time, depressed central nervous and respiratory systems, and low body temperature may subject research animals to unnecessary physiological and environmental hazards.

Yohimbine hydrochloride is an efficient antagonist for xylazine-immobilized deer. Hsu and Shulaw (1984) used intravenous injection of yohimbine hydrochloride in the recurrent tarsal vein to antagonize xylazine hydrochloride immobilization in mule deer (*Odocoileus hemionus*). Intravenous injections of yohimbine hydrochloride into the jugular vein (Mech et al., 1985) and an auricular vein (D. F. Cottam, pers. comm.) have been used to reverse the effects of xylazine in white-tailed deer immobilized with xylazine hydrochloride and ketamine hydrochloride. However, intravenous injections can be difficult in field research due to poor ambient light conditions when deer are captured, and inexperience with intravenous injection techniques.

Intramuscular injections are easy to administer and may be suitable for situations encountered during field research. Our objective was to evaluate the safety and effectiveness of intramuscular injections of yohimbine hydrochloride for the antagonism of 22 xylazine-immobilized white-tailed deer.

Eighteen free-ranging deer were used. These included three male and four female fawns, and three male and 11 female adults. The fawns were 5 to 9 mo of age; adults were ≥17 mo. Animals were captured on Remington Farms (39°10′ to 39°12′N, 76°14′ to 76°10′W), a wildlife demonstration area located near Chestertown, Maryland (USA). Free-ranging deer were captured with a 21.3 × 21.3-m dropnet using the methods of Conner et al. (1987). Capture operations took place between 15 February and 21 March, and 7 October and 13 November 1986, from sunset to 2 hr after sunset. After capture, we visually estimated the weight of each deer and administered intramuscular in-

jections of 1.1 to 2.2 mg/kg xylazine hydrochloride (Rompun, Miles Laboratory Inc., Shawnee, Kansas, USA; 100 mg/ml) and 1.8 to 4.4 mg/kg ketamine hydrochloride (Ketaset, Bristol Laboratories, Syracuse, New York, USA; 100 mg/ml). To reduce stress, masks were placed over the head of each deer, and talking was kept minimal and low. Radio-collars were attached to adult deer.

Four captive males were housed at the Deer and Duiker Research Facility of The Pennsylvania State University (University Park, Pennsylvania, USA) in separate 1.4-ha enclosures. The four captive deer were weighed and administered intramuscular injections of 1.5 to 2.0 mg/kg xylazine hydrochloride on 16 September 1986. No deer, free-ranging or captive, were immobilized more than once.

The xylazine hydrochloride was antagonized with intramuscular injections of 0.4 mg/kg yohimbine hydrochloride (Sigma Chemical Co., St. Louis, Missouri, USA; 5 mg/ml) into the upper thigh. Sedation time was defined as the time from drug administration to the time when animals appeared sedated under the capture net or could be safely handled; and recovery time was defined as the time from injection of yohimbine hydrochloride to the time when deer could stand and walk on their own. Sedation time and recovery time were recorded at the capture site and used to calculate immobilization time, which was defined as the time when deer appeared sedated to the time of yohimbine hydrochloride injection.

After recovery with yohimbine hydrochloride, all deer were monitored as long as possible for noticeable problems such as stumbling, falling, uncoordinated locomotion, and accidental injury. Free-ranging deer recovering from yohimbine hydrochloride injection were followed for 50 to 100 m after leaving the trap site. Two of the three adult males and six of the eight adult females were monitored using radiotelemetry for 3 hr the evening following their capture. Captive deer were observed daily after recovery.

Mean immobilization and recovery times were 36.7 and 11.6 minutes, respectively, for all deer used in the study (Table 1). We found a large difference in the recovery times of captive and free-ranging deer. Captive deer immobilized only with xylazine hydrochloride were expected to recover faster than free-ranging deer immobilized with xylazine hydrochloride and ketamine hydrochloride. Kreeger and Seal (1986) found that yohimbine did not reverse the effects of ketamine in gray wolves. However, recovery time for captive deer was two to three times longer than the recovery time for any other group. This could be due to captive deer being accustomed to handling. The desire to move from the capture site could be less for captive deer than for free-ranging deer.

Within the free-ranging deer, males appeared to recover slightly faster than females. Fawns and adults recovered at the same rates within each sex. This was not expected, since fawns were immobilized for a shorter time. However, sample size was low for all age and sex groups, and some differences could have occurred in drug dosages.

No adverse effects were seen among deer recovering from immobilizations antagonized with intramuscular injections of yohimbine hydrochloride. Neither radiomonitored deer or captive deer showed any signs of abnormal behavior. Although a few deer stumbled, all were able to walk or run, and clear obstacles; all appeared alert to noise.

Benefits of yohimbine hydrochloride antagonism of xylazine hydrochloride include decreased risk of aspiration pneumonia, reversal of bradycardia and respiratory depression, and avoidance of predation, thus reducing the amount of aftercare needed and overall risk to the recovering animal (Hsu and Shulaw, 1984). Only minor differences in recovery time were evident between intravenous injection of yohimbine hydrochloride by Hsu and Shulaw (1984)

TABLE 1. Mean immobilization and recovery times for chemically-immobilized white-tailed deer, 1986.

Age and sex	Immobilizing drugs (mg/kg)		Immobilization time (min)			Yohimbine hydrochloride (mg/kg)	Recovery time (min)		
	Xylazine hydrochloride	Ketamine hydrochloride	Number of deer	Mean	SE		Number of deer	Mean	SE
Adult male	1.1-2.2	1.8-4.4	3	43.3	3.3	0.4	3	7.3	2.4
Adult male[a]	1.5-2.0		4	29.8	2.1	0.4	4	28.1[b]	8.3
						0.4	3	20.2[c]	3.4
Adult female	1.1-2.2	1.8-4.4	8	41.8	8.7	0.4	8	8.6	1.7
Fawn male	1.1-2.2	1.8-4.4	3	30.0	7.6	0.4	3	5.7	3.3
Fawn female	1.1-2.2	1.8-4.4	4	33.8	2.4	0.4	4	8.9	1.9
Overall means			22	36.7	3.4		22	11.6[b]	2.3
							21	9.7[c]	1.4

[a] Captive deer.
[b] Calculations with docile yearling.
[c] Calculations without docile yearling.

(mean = 4.4, SD = 5.4 min.) and Mech et al. (1985) (median = 6.0, SE = 2.1 min.), and intramuscular injections in our study. We expected a larger difference, considering that 16 of 20 deer from Hsu and Shulaw (1984) were immobilized ≥60 min (xylazine dose = 2.8 mg/kg), and Mech et al. (1985) used mean dosages of ≥0.28 mg/kg yohimbine hydrochloride on 11 of 13 deer. Although differences in study design could account for part of the difference in recovery time, we believe our results can be used to demonstrate the effectiveness of intramuscular injections of 0.4 mg/kg yohimbine hydrochloride for antagonism of xylazine hydrochloride in white-tailed deer.

There are several advantages to using intramuscular injections on wild trapped deer. Intramuscular injections avoid problems associated with locating peripheral veins, and they can be easily administered under field conditions without adequate lighting. We believe these advantages compensate for the difference in recovery time between intramuscular and intravenous injections of yohimbine hydrochloride. Based on our results, we believe that intramuscular injections of 0.4 mg/kg yohimbine hydrochloride can safely and effectively reverse xylazine hydrochloride-induced immobilization of white-tailed deer.

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