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Alternative bleeding method for the hunt for young grey seals (*Halichoerus grypus*): common carotid arteries versus axillary arteries

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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ABSTRACT

In recent years, the hunt for young grey seals (*Halichoerus grypus*) on the Magdalen Islands, Québec has targeted utilization of the meat rather than that of the pelt. Mandatory bleeding by severance of the axillary arteries and surrounding blood vessels may cause contamination of the meat by debris on the ground where these animals are killed. This study aimed to evaluate an alternative bleeding method based on severance of the common carotid arteries and surrounding blood vessels, which should reduce contamination of the meat normally collected. Bleeding time by severance of the common carotid arteries was overall similar to that by severance of the axillary arteries, and did not vary with sex or body mass. Results demonstrate that the proposed alternative is at least as efficient as severance of the axillary arteries from the perspective of animal welfare and could thus be used during the hunt for young grey seals.

INTRODUCTION

The commercial seal hunt in Canada is strictly regulated to ensure practices that avoid cruelty and promote animal welfare by aiming for a quick death with minimal or no suffering. In this context, the Canadian regulations are based on scientific advice, including the recommendations from an independent veterinarians' working group (Smith et al. 2005). Thus, according to the Marine Mammal Regulations (MMR) of the Fisheries Act of Canada (Anonymous 2018), hunters who kill seals must follow a three-step process: stun or kill the animal by fracturing its skull with an approved weapon (hakapik, club, or shot from a rifle of sufficiently high caliber), ensure by manual palpation that the skull has been crushed, and bleed the seal by severance of the axillary arteries and surrounding blood vessels. While the first two steps are the most important because they establish that the seal is unconscious and cannot perceive pain, rapid bleeding is essential to prevent the risk of recovery and confirm the animal's death (Smith et al 2005). This last step starts with an incision of the skin and blubber along the carcass' ventral midline (the normal process for skinning a seal for its pelt), followed by severance of blood vessels deep in each of the axillary regions (under the fore flippers), after which the carcass is turned over on its ventral side to facilitate blood loss (Figure 1a). Since incision of the skin along the ventral midline is also used to skin the carcass, this bleeding method is practical and appropriate for the hunt for young harp seals (*Pagophilus groenlandicus*) which occurs on snow or ice and has for many years targeted their pelt as well as their meat.

In recent years, an increased interest for the commercial utilization of seal meat has been emerging. The hunt for young grey seals (*Halichoerus grypus*) in the Gulf of St. Lawrence, currently carried out mostly by sealers from the Magdalen Islands, Québec differs in two important ways from the hunt for young harp seals: 1) most animals are killed on sandy or rocky ground, and 2) meat is the main product collected from these animals. During previous hunts, it was observed that bleeding by severance of the axillary arteries could cause substantial contamination of the meat by sand, pebbles or other debris when carcasses were turned on their ventral side for bleeding and subsequently dragged on the ground to a cleaner site for skinning and evisceration (Réjean Vigneau, personal communication). An alternative bleeding method that would limit contamination of the meat while still ensuring rapid blood loss according to good principles of animal welfare could therefore improve the quality of products derived from the hunt for young grey seals.

The common carotid arteries and surrounding blood vessels, located on the ventral aspect of the neck, are the blood vessels that are severed for regulatory bleeding of most livestock species in Canada (CFIA 2019). In addition to being relatively superficial and having a large diameter favouring rapid exsanguination of the animal, the carotid arteries provide direct blood supply to the brain. Therefore, aside from being practical by the location and size of these cervical blood vessels, their severance could directly interfere with oxygen supply to the brain. As an alternative to bleeding by severance of the axillary arteries, the present study proposed to bleed the animals by severance of the two common carotid arteries (Figure 1b). Contamination of targeted muscle tissues by debris on the ground would thus be greatly reduced since meat from the neck is not collected for human consumption, as opposed to the thoracic muscle masses exposed when severing the axillary arteries. The proposed hypothesis is that this alternative bleeding method should be at least as efficient as that by severance of the axillary arteries since two major arteries directly supplying blood to the brain would be severed.

MATERIALS AND METHODS

This study was conducted in January 2018 during a commercial hunt for grey seals on Dead Man's Island, 16 km south-east of Île-du-Havre-Aubert, Magdalen Islands, Québec and during scientific sampling conducted by Fisheries and Oceans Canada (DFO) on Saddle Island, Nova Scotia, in the Northumberland Strait. Recently weaned grey seals, prior to their departure at sea at an average age of 40 days (Noren et al. 2008), were stunned by several blows from a hakapik followed by mandatory palpation of their skull, according to the MMR (Anonymous 2018). Immediately afterwards, animals were bled alternately by either one of two methods: severance of the axillary arteries and surrounding blood vessels, or severance of the common carotid arteries and surrounding blood vessels (Figure 2). The exact location of the cut of the carotid arteries along the neck was not recorded but was usually in its mid-region. Up to three hunters, all experienced professional sealers, carried out the bleeding process in the harvest on Dead Man's Island, whereas a single experienced technician was involved on Saddle Island.

Bleeding time was recorded in each animal and divided into two parts. The first part consisted of the time elapsed between the first skin incision and the first artery cut (as determined by a pulse of blood coming out of the cut vessel), while the second part consisted of the time elapsed between the first artery cut and the end of a steady blood flow (i.e., duration of the actual bleeding). Bleeding times were measured by a veterinarian who had conducted a similar study on harp seals (Daoust and Caraguel 2012), ensuring comparability between bleeding times reported for both seal species. Following death, the sex of each animal was determined. Animals collected during the DFO sampling were also weighed (± 0.5 kg) with a numerical scale suspended from a wooden stick.

Bleeding times for the two techniques (i.e., axillary arteries and common carotid arteries) and between collection sites were compared with two-tailed Student's tests on means for each of the two parts. Potential effects of sex and body mass on duration of bleeding were examined using an ANOVA and a linear model tied to a graphic analysis, respectively. Likewise, the potential interaction between the bleeding method used and the collection site was investigated using a linear model. *P* values were considered significant when <0.05, and all statistical analyses were performed within the *R* environment (R Core team 2017).

The authors of this study held a DFO permit for harvesting seals for scientific purposes (#IML 2018-01), and the study's protocol was reviewed and approved by the Animal Care Committee of the University of Prince Edward Island (#17-001).

RESULTS

A total of 62 seals (32 on Dead Man's Island and 30 on Saddle Island; 21 males and 41 females) were included in this study. Only seals collected on Saddle Island were weighed, with body mass varying between 32.0 and 63.0 kg (mean: 47.8 ± 1.3 kg).

A summary of the results is presented in Table 1. The first part of bleeding was shorter by severance of the common carotid arteries (mean: 3.3 ± 0.8 sec) than by severance of the axillary arteries (mean: 6.4 ± 0.6 sec; $P < 0.001$). However, there was no difference between these two methods with regard to the second part of bleeding (means: 29.2 ± 2.0 sec and 27.9 ± 2.3 sec for common carotid and axillary arteries, respectively; $P = 0.663$). Likewise, the total duration of bleeding (sum of the two parts) did not differ between the two methods (means: 32.5 ± 2.1 sec and 34.3 ± 2.4 sec for common carotid and axillary arteries, respectively; $P = 0.556$). Duration of the different parts of bleeding did not differ between males and females ($P = 0.346$ and $P = 0.317$ for the first and second parts of bleeding, respectively). Moreover, duration of bleeding did not correlate with the animal's body mass ($R^2 = 0.02$).

The first part of bleeding was shorter for animals collected on Saddle Island (mean: 4.2 ± 0.4 sec) than for those collected on Dead Man's Island (mean: 6.3 ± 0.9 sec; $P = 0.018$). However, there was no difference in times for completion of the second part of bleeding ($P = 0.583$) nor in total bleeding times ($P = 0.917$) between collection sites (Table 2). The site effect on the length of the first part of bleeding did not vary according to the bleeding method used (i.e., axillary or carotid arteries) (Method*Site interaction term estimate = 0.04 ± 1.96, $P = 0.983$).

DISCUSSION

The MMR (Anonymous 2018) mandate a three-step process when killing seals for personal or commercial purposes in order to comply with high standards of animal welfare. The aim of the bleeding step is to ensure that the animal will not recover from stunning. It is therefore critical that exsanguination of the animal is performed with minimal delay following stunning, so that rapid blood loss precludes recovery of cerebral function.

Bleeding time in animals is influenced by several factors such as the killing method, the size of the animal, its species (larger total blood volume relative to body mass in diving mammals than in non-diving mammals, correlating roughly with the species` diving capabilities; Annalisa et al. 2015), and bleeding site(s). All these factors need to be taken into consideration when comparing the efficacy of different bleeding methods.

In terrestrial mammals, the left and right internal carotid arteries (branches of the corresponding common carotid arteries) and the left and right vertebral arteries are the four arterial vessels supplying blood to the brain, but the relative contribution of these vessels varies among species. For example, in humans the two internal carotid arteries provide 82% of the blood to the brain (Boyajian et al. 1995), whereas in dogs the basilar artery, which originates from the two vertebral arteries, is the larger source of blood to the brain (Evans and de Lahunta 2013). Although details of cerebral blood supply are not as well known in seals, this study's observations show that, in grey seals, severance of the common carotid arteries and concurrently of other surrounding blood vessels in the neck resulted in rapid and massive blood loss, subjectively at least as voluminous as that from severance of the axillary arteries and surrounding blood vessels. Whether or not the vertebral arteries were also severed in the process was not determined. However, based on their anatomical origin from the left and right subclavian arteries near the base of the heart in dogs, a ventral cut near the base of the neck rather than more cranially would stand a better chance of reaching these arteries before they travel dorsally into soft tissues on their way to the vertebrae. Severing also these blood vessels would further reduce blood supply to the brain.

Results of this study show that blood vessels of the neck are an appropriate alternative for bleeding young grey seals since total bleeding time was similar to that by severance of the axillary arteries. This alternative method would therefore result in rapid bleeding of the animals while also limiting contamination of meat that might be collected for human consumption. Moreover, the fact that the seal's head is slightly raised from the ground as it is hooked to drag the carcass to a cleaner site would further reduce potential contamination of the exposed meat (Figure 1b).

Interestingly, severance of blood vessels of the neck resulted in a decreased duration of the first part (i.e., time elapsed between first skin incision and first artery cut) compared with severance of the axillary arteries. The distance between the skin of the neck and the common carotid arteries was likely less than that between the skin of the mid-ventral region of the thorax and the axillary arteries, thus allowing more rapid access to the common carotid arteries by the knife. Such reduction in the interval between first skin incision and first artery cut and thus start of bleeding is advantageous since the animal may be only unconscious as a result of stunning (e.g., Smith et al. 2005). In that situation, it is the bleeding which results in the animal's death, and any protocol that limits the interval between loss of consciousness and cerebral death promotes a hunt that further complies with good principles of animal welfare.

The effect of harvest site on the first part of bleeding might be explained by variability among hunters in their knife handling skills or techniques. Although the time from the first skin incision to the start of blood loss was statistically different for animals bled on Saddle Island compared to those bled on Dead Man's Island, the 2-sec difference between means is unlikely to be physiologically or clinically significant. Moreover, this time difference is negligible compared to the time required to palpate the skull to ensure that it is fractured (step 2 of the three-step process), reach the knife, and position the animal prior to initiating the first cut. The fact that the second part of bleeding was consistent between sites indicates that, once arteries are severed, variability in cutting techniques no longer affects bleeding duration. It therefore appears that, with experienced harvesters, techniques or skills have minimal to no effect on overall bleeding times, and that the bleeding method (i.e., severance of carotid vs axillary arteries) does not affect hunter-induced variability in bleeding times.

In humans, sudden arrest of blood supply to the brain can cause loss of consciousness in less than 5-10 sec through lack of oxygen (Guyton and Hall 2006). Similarly, severance of large blood vessels of the neck could cause very rapid cerebral anoxia, directly by severance of the common carotid arteries (and possibly also the vertebral arteries) and indirectly by causing a severe drop in blood pressure following massive blood loss.

The current regulations stipulate that a seal must not be skinned before at least 1 min has elapsed after the two axillary arteries have been severed, which corresponds to the second part of bleeding defined in this study. The second part of bleeding lasted between 8 and 68 sec, indicating that the 1-min mandatory bleeding time is sufficient to ensure exsanguination of young grey seals, whether the axillary or carotid arteries are severed.

This study is the first to report bleeding times for young grey seals. A study of bleeding time following severance of the axillary arteries in young harp seals was done by Daoust and Caraguel (2012). A comparison of bleeding times reported by these authors with those determined in this study (Table 3) shows a longer duration ($P < 0.001$) of the first part but a shorter duration ($P < 0.001$) of the second part and of the total bleeding time in harp seals as compared to grey seals. These differences could be explained by methodological differences between the hunt for young grey seals and that for young harp seals. A large proportion of the harp seals were killed from a distance by a bullet to their head (.222 or .223 caliber) and quickly brought on board of a vessel where they were bled. Since these animals were killed primarily for their pelt, hunters who were bleeding them needed to be careful when cutting the skin along the ventral midline of the carcass before reaching the axillary arteries. This could possibly explain the increased length of the first part of bleeding (time elapsed between first skin incision and first artery cut) in harp seals. Conversely, the shorter duration of the second part of bleeding in harp seals could be explained by the loss of a large amount of blood from the head wound caused by the bullet before the carcass was retrieved and bled. Moreover, young harp seals are substantially smaller than young grey seals (average mass at weaning: 25-40 kg and 55 kg for harp and grey seals, respectively [Chabot and Stenson 2002; Geraci and Lounsbury 2005; Bowen et al. 2015]). Blood volume being proportional to the logarithm of body mass (e.g., Keiver et al. 1987), young harp seals thus have a smaller blood volume, which could also explain a shorter bleeding time. Importantly, no grey seal was observed to recover consciousness between stunning and the end of bleeding, indicating that the slightly longer bleeding time in these animals was not associated with an increased risk of suffering.

CONCLUSION

Results from the present study suggest that severance of the common carotid arteries and surrounding blood vessels located in the ventral part of the neck represents a rapid bleeding method for young grey seals and would thus be appropriate from an animal welfare perspective. This method is as quick as that by severance of the axillary arteries and surrounding blood vessels and could be advantageous by reducing contamination of muscle masses collected for human consumption by debris on the ground.

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TABLES

Table 1. Comparison of bleeding time (sec) following severance of axillary or common carotid arteries in recently weaned grey seals. The first part refers to the time elapsed between first skin incision and first artery cut. The second part refers to the time elapsed between first artery cut and end of steady blood flow.

Bleeding time	Bleeding method	Mean	Standard error	Range	N	*P* value
First part	Axillary arteries	6.4	0.6	2-20	31	<0.001
	Carotid arteries	3.3	0.8	1-8	31	
Second part	Axillary arteries	27.9	2.3	8-68	31	0.663
	Carotid arteries	29.2	2.0	12-64	31	
Total duration	Axillary arteries	34.3	2.4	11-72	31	0.556
	Carotid arteries	32.5	2.1	15-67	31	

Table 2. Comparison of bleeding time (sec) in recently weaned grey seals harvested either during DFO scientific sampling on Saddle Island, or during a commercial hunt conducted on Dead Man's Island. Seals collected during the DFO hunt were bled by an experienced technician, while seals collected during the commercial hunt were bled by either one of three experienced sealers.

Bleeding time	Harvest site	Mean	Standard error	N	*P* value
First part	Saddle Island	4.2	0.4	30	0.019
	Dead Man's Island	6.3	0.9	32	
Second part	Saddle Island	29.4	1.9	30	0.583
	Dead Man's Island	27.7	2.4	32	
Total duration	Saddle Island	33.6	1.9	30	0.917
	Dead Man's Island	34.0	2.5	32	

Table 3. Comparison of bleeding time (sec) by severance of axillary arteries in recently weaned grey seals (this study) and harp seals (Daoust and Caraguel, 2012).

Bleeding time	Species	Mean	Standard error	Range	N	*P* value
First part	Grey seal	6.4	0.6	2-20	31	< 0.001
	Harp seal	10.9	0.4	5-26	90	
Second part	Grey seal	27.9	2.3	8-68	31	< 0.001
	Harp seal	11.0	0.3	5-32	143	
Total duration	Grey seal	34.3	2.4	11-72	31	< 0.001
	Harp seal	21.4	0.6	12-35	85	

FIGURES

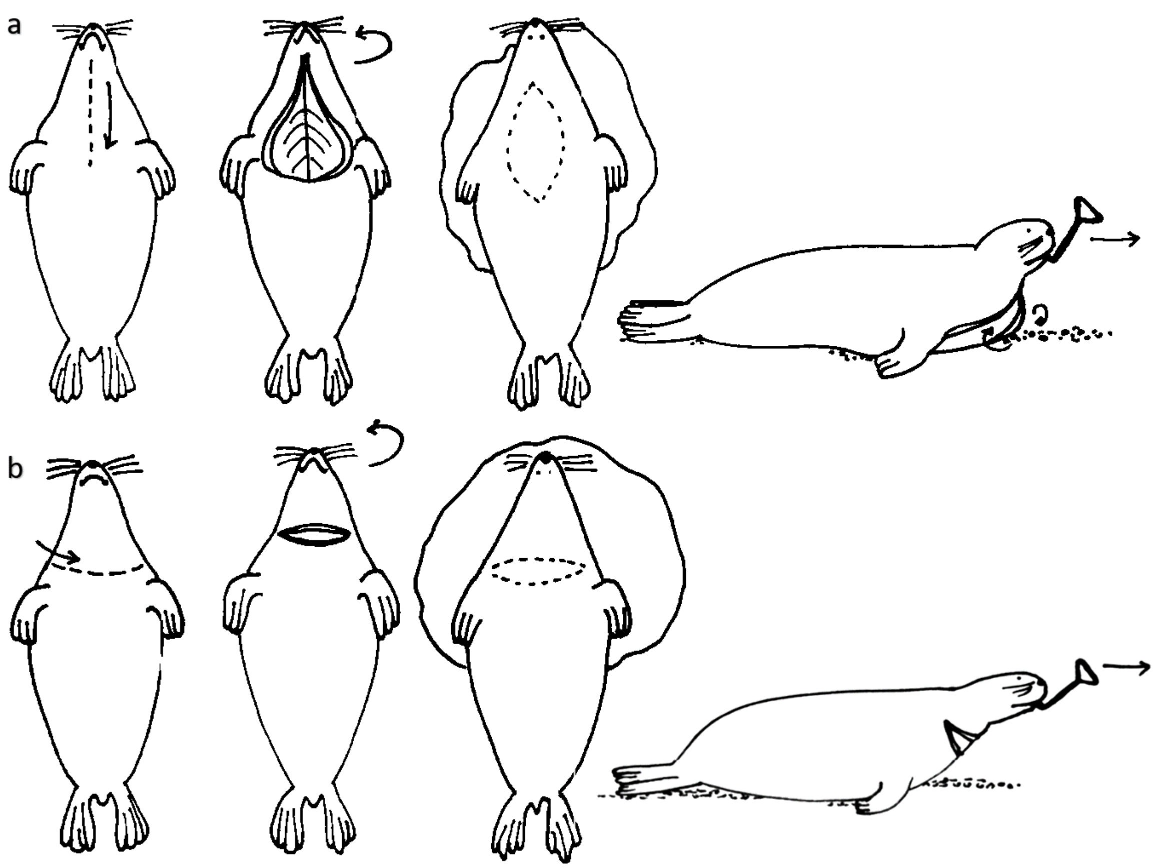

Figure 1. Bleeding methods by severance of (a) the axillary arteries and (b) the carotid arteries in recently weaned grey seals. The seal is first placed on its back for skin and blood vessel incision. It is then flipped over ventrally to facilitate blood loss for at least one minute. Seals are then dragged on the ground for transfer to the hunting vessel. Thoracic muscle masses are exposed and in contact with the ground when seals are bled by severance of the axillary arteries, whereas they are not exposed when the carotid arteries are severed. Image by CC Sauvé.

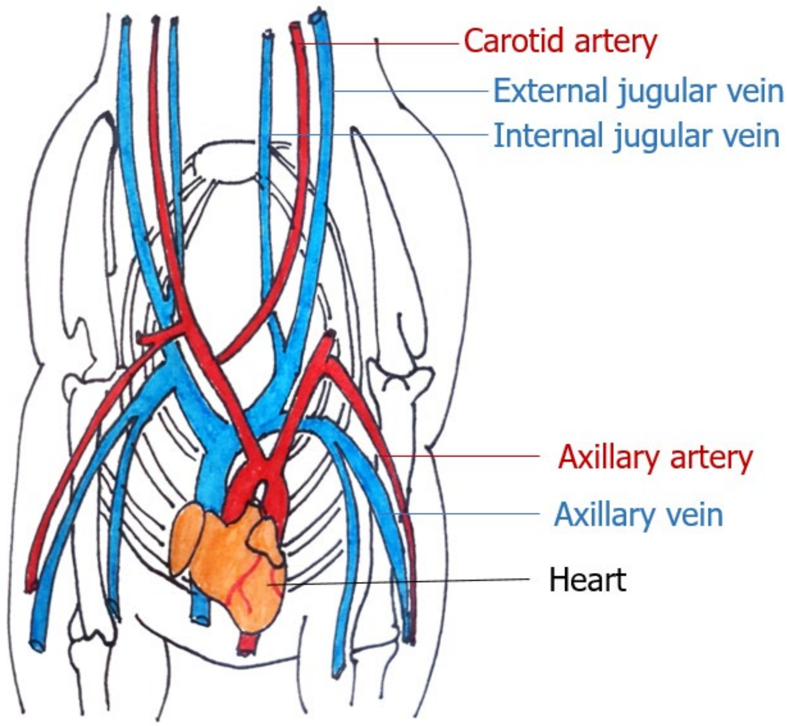

Figure 2. Cranio-caudal section of the thoracic region of a caniform mammal displaying the main blood vessels involved in the two bleeding methods considered in this study, i.e., the carotid arteries and surrounding large vessels, and the axillary arteries and surrounding large vessels. Image by CC Sauvé.