Montréal, le 22 septembre 2015

Commission de l'agriculture, des pêcheries,
de l'énergie et des ressources naturelles
Édifice Pamphile-Le May
1035, rue des Parlementaires
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Objet : Mémoire présenté par le Centre consultatif des relations juives et israéliennes-Québec sur le projet de loi n° 54

Monsieur le Ministre,
Monsieur le Vice-Président,
Mesdames et Messieurs les Parlementaires,

Introduction

Le Centre consultatif des relations juives et israéliennes (CIJA-Québec) est l'agence représentative des institutions communautaires juives locales. Il est le trait d'union entre la communauté juive et les trois paliers du gouvernement, les représentants des médias, le milieu des affaires et les universités. CIJA Québec défend les intérêts de la communauté juive à tous les niveaux du gouvernement et travaille avec les politiciens de tous les principaux partis politiques sur les questions de politique nationale et étrangère qui touchent les juifs québécois et canadiens.

Projet de loi 54 — *Loi visant à l'amélioration de la situation juridique de l'animal*

Nous saluons les efforts du gouvernement pour veiller au bien-être et à la sécurité des animaux au Québec, à travers le projet de loi 54, *Loi visant à l'amélioration de la situation juridique de l'animal*, mais nous tenons ici à corriger des idées fausses sur l'abattage rituel juif. Le bien-être animal est très valorisé par la communauté juive; le judaïsme interdit formellement la cruauté gratuite envers les animaux. C'est pourquoi l'abattage rituel juif, ou *shechita,* est un processus aussi rapide et indolore qu'humainement possible. En effet, dans sa présentation du 14 septembre 2015 devant le comité de l'Assemblée nationale chargé d'étudier ce projet de loi, *Animal Legal Defense Fund* a reconnu que l'abattage rituel, lorsqu'il est correctement effectué, est humain et ne fait pas preuve de cruauté indue envers les animaux.

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Compte tenu de ce qui précède, nous voudrions souligner que l'abattage rituel juif est conforme aux normes énoncées dans l'article 12 de la Loi sur le bien-être et la sécurité de l'animal :

12. Lorsqu'un animal est abattu ou euthanasié, son propriétaire, la personne en ayant la garde ou la personne qui effectue l'abattage ou l'euthanasie de l'animal doit s'assurer que les circonstances entourant l'acte ainsi que la méthode employée ne soient pas cruelles et qu'elles minimisent la douleur et l'anxiété chez l'animal. La méthode employée doit produire une perte de sensibilité rapide, suivie d'une mort prompte. La méthode ne doit pas permettre le retour à la sensibilité de l'animal avant sa mort.

La personne qui effectue l'abattage ou l'euthanasie de l'animal doit également constater l'absence de signes vitaux immédiatement après l'avoir effectué.

Abattage rituel juif

Des experts scientifiques sur cette question ont confirmé que l'abattage rituel, tel que pratiqué selon les spécifications rigoureuses de la tradition juive, est plus humain que les techniques conventionnelles d'abattage. Parmi eux, le docteur Temple Grandin, experte renommée et professeure de sciences animales à l'Université d'État du Colorado, a conçu des installations de manutention de bétail en Europe, Amérique du Nord, Australie et ailleurs, et a consacré sa vie à rendre l'abattage des animaux plus humain. En 2011, le docteur Grandin a écrit : « J'ai remarqué que lors de l'abattage rituel cachère, l'animal n'a eu presque aucune réaction lorsque sa gorge a été tranchée. Un mouvement de ma main près de son visage a suscité une plus grande réaction. » [1]

Selon la tradition juive, la viande doit être cachère avant d'être consommée et doit satisfaire à certains critères : le type d'animal abattu, la méthode d'abattage de l'animal et le traitement de la viande après l'abattage. La plupart des interprétations de ces critères se rapportent à l'hygiène et à la santé. Selon la tradition juive, l'animal doit être vivant, en bonne santé et conscient avant l'abattage. L'obligation de l'étourdir avant de l'abattre éliminerait pour les juifs pratiquants toute possibilité de consommer de la viande. Contrairement à la croyance populaire, la nourriture cachère, incluant la viande cachère, n'est pas bénie par un rabbin.

Les préoccupations du judaïsme à l'égard du traitement des animaux sont sans précédent. Le judaïsme a été la première religion à exiger avec clarté et intransigeance de bien traiter les animaux. Basé sur l'interprétation biblique, le judaïsme a fixé comme objectif global l'obligation de prévenir la souffrance de tous les animaux. Infliger gratuitement de la douleur à un animal est considéré comme un acte immoral et un péché.

L'abattage des animaux selon la tradition religieuse juive est étroitement réglementé et comprend des spécifications visant à empêcher que des souffrances soient infligées aux animaux. Ces spécifications comportent les éléments suivants :

[1] Temple Grandin, *Maximizing Animal Welfare in Kosher Slaughter*, The Forward, 27 avril 2011. http://forward.com/opinion/137318/maximizing-animal-welfare-in-kosher-slaughter/

(a) **Formation rigoureuse de celui qui pratique l'abattage rituel** – Des années de formation sont nécessaires avant d'être reconnu apte à pratiquer l'abattage rituel.

(b) **Caractéristiques de la lame** – L'abattage rituel cachère nécessite l'utilisation d'une lame de rasoir unique, appelée « Chalaf », sans aucune entaille ou dentelure et comparable seulement à un bistouri. Toute imperfection de cette lame entraîne l'interdiction de consommer la viande de l'animal abattu.

(c) **Taille de la lame** – La longueur de la lame doit correspondre à deux fois la longueur du cou de l'animal à abattre.

(d) **Méthode de la shechita** – L'incision doit être faite en un mouvement continu rapide, sans exercer de pression contre le cou de l'animal.

(e) **Lieu précis de l'incision** – L'incision doit être faite à un endroit précis, ne coupant que les tissus et les vaisseaux sanguins.

La méthode de *shackle and hoist* (suspension de l'animal) n'est utilisée dans aucun **abattoir au Québec où l'abattage rituel cachère est pratiqué**. Là où l'abattage rituel a lieu au Québec, l'abattoir utilise une boîte d'immobilisation qui minimise le stress de l'animal. Lorsqu'un animal est abattu selon les normes de la l'abattage rituel juif, il est effectivement rendu étourdi par la perte rapide de fonction du cerveau et par une interruption du débit sanguin cérébral.[2] En fait, *Animal Legal Defense Fund* a déclaré sur son site Web « que l'abattage rituel casher, *lorsqu'il est effectué correctement*, est au moins aussi humain que l'étourdissement avant l'abattage. Qu'est-ce que cela veut dire? En bref, cela signifie que la *shechita* est effectuée correctement lorsqu'un *shochet* (un mâle juif spécialement formé) coupe les artères carotides de l'animal à l'aide d'un couteau très acéré et sans aucune imperfection, provoquant ainsi une perte de conscience immédiate de l'animal. Le docteur Temple Grandin, une sommité en matière de pratiques d'abattage sans cruauté, insiste sur le fait que les animaux abattus dans des conditions optimales ne démontrent que peu ou pas de stress à la coupe rituelle avant de perdre conscience. »[3]

Conclusion

Des études scientifiques et les preuves acceptées par les principaux groupes de défense des animaux démontrent que l'abattage rituel juif est « une technique fiable et efficace utilisée dans un processus d'étourdissement et d'abattage »[4], tel que l'a affirmé le docteur

[2] Dr. Stuart Rosen, *Scientific Update* 2015, Shechita UK, p.1, http://www.shechitauk.org/uploads/tx_resources/Shechita_-_Scientific_Update_2015_01.pdf
[3] Carmine Lippolis, Animal Legal Defense Fund Research Fellow, "*Kosher Slaughter Laws and an End to 'Shackle-and-Hoist' Restraint,* 23 janvier 2105 http://aldf.org/blog/kosher-slaughter-laws-and-an-end-to-shackle-and-hoist-restraint/
[4] *Supra* note 2.

Temple Grandin. Il assure ainsi le même degré de désensibilisation que les techniques d'étourdissement avant l'abattage.

Lorsqu'un animal est abattu selon les normes de l'abattage rituel juif, il est effectivement étourdi par la perte rapide de fonction du cerveau et par une interruption de la circulation sanguine cérébrale[5], minimisant chez l'animal douleur, anxiété et entraînant une mort rapide.

Nous sommes confiants que ce mémoire démontre que l'abattage rituel cachère est conforme aux normes les plus élevées de traitement humain des animaux.

Pour votre information, nous avons joint une série d'articles scientifiques concernant les aspects techniques du processus.

Lectures suggérées dans l'annexe :

Shechita – Scientific Update 2015, Dr Stuart Rosen (Shechita UK)
http://www.shechitauk.org/uploads/tx_resources/Shechita_-_Scientific_Update_2015_01.pdf

Psychology insights into Shechita, S.D. Rosen, MA, MD, FRCP
Veterinary Record 2004; 154:24, pages 759-765
http://www.shechitauk.org/fileadmin/user_upload/pdf/Physiological_insights_into_Shechita__S.D.Rosen__Veterinary_Record_2004.pdf

Religious slaughter and animal welfare: a discussion for meat scientists, Meat Focus International – Mars 1994, pages 115-123, publié par CAB International, par Temple Grandin et Joe M. Regenstein
http://www.grandin.com/ritual/kosher.slaugh.html

[5] *Ibid.*

Shechita – Scientific Update 2015

In an animal subjected to proper *Shechita*, brain function is impeded extremely rapidly by the collapse in cerebral blood flow rendering the animal s*tunned.* Combined with this, is the fact that, due to detailed *Halachic* requirements of the blade and motion of the incision, direct stimulation of nociceptors in the neck is below a level adequate to evoke a sentient response.

Shechita is reliable and effective as a technique for an integral stun and slaughter. Its efficacy has been independently attested to by international expert Professor Temple Grandin. In her behavioural study[1], a deliberately very light degree of restraint was deliberately employed for animals undergoing *Shechita*, and yet there was no flinching and no reflex defence response suggestive of any sensation of pain.

Despite this there have been numerous attempts to discredit *Shechita*, using a combination of poor science and agenda-driven misinterpretation.

Tissue damage and pain

Gregory[2] warns that 'the cuts which are used ….. involve substantial tissue damage in areas well supplied with pain receptors. The rapid decrease in blood pressure which follows the blood loss is readily detected by the conscious animal and elicits fear and panic. Poor welfare also results when conscious animals inhale blood because of bleeding into the trachea.'

The key point here is manifestly untrue. If an animal's blood pressure falls very rapidly it loses consciousness, and is not in a position to 'detect' its fall in blood pressure, neither does this elicit fear and panic'. There is simply no evidence of this at all. Clearly it would be very poor welfare if a conscious animal were to inhale blood because of bleeding into the trachea. However, with *Shechita*, the animal a) is not conscious and b) our animals are restrained such that the blood gushes away from the neck outwards, it does not flow into the trachea.

Tissue manipulation and pain

The same authors assert that 'manipulating tissues that are rich in sensory nerve endings, as are the structures in the neck and as occurs during this manual examination of the neck wound, will stimulate neurosensory pathways to the brain. This is likely to lead to the sensation of pain if the animal is conscious.'

This would be true under other circumstances, but in the course of *Shechita*, the animal loses consciousness so rapidly that it is not conscious at this point and so it is *un*reasonable to conclude that examination of the neck structures will cause pain.

Data on slaughter of calves and persisting cerebral blood flow due to 'ballooning'

Anil and colleagues[34], described the process through which carotid ballooning (occlusion of the severed ends of the carotid arteries by a combination of elastic recoil, platelet aggregation and smooth muscle constriction) "could result in a maintenance of mean arterial blood pressure and that the mean vertebral blood flow can be held at about 30% of its initial level for approximately three minutes. Therefore, the anatomical difference in brain perfusion between cattle, deer and other species can play an important role in the contribution to continued brain function, should carotid ballooning occur."

This mechanism is plausible – but has nothing to do with *Shechita*! In the latter, the animals are held in a restraining pen in such a way that the head is prevented from flopping forward and occluding the carotids. With the arterial ends apart, platelet aggregation and elastic recoil alone do not prevent the free flow of blood. The spurious suggestion that vertebral artery flow will maintain the brain's circulation after *Shechita* has been dealt with elsewhere[5]. In fact, after the *Shechita* incision, there is a precipitous fall in cerebral perfusion pressure that causes neuronal dysfunction, stunning and rapid brain death.

Exsanguination

Anil and colleagues have made much recently of a demonstration that there is no appreciable differences in the bleed out between animals pre-stunned before slaughter and those killed by neck incision[6]. The key point here is that Anil and colleagues try to suggest that the *only point* of religious slaughter is the rate and degree of blood loss. Once again it seeks to devalue the religious approach and anyway has nothing to do with animal welfare.

Data vs misinterpretation in poultry slaughter

In a study by Barnett et al [72], performed in Australia, measurements were made on poultry undergoing *Shechita*; the birds were watched closely and their responses before, during and after slaughter were noted. The time from removal from the crate to performance of the cut averaged 5 seconds; onset of muscular contractions and loss of postural one occurred after

about 12 seconds and, interestingly, only 4% of birds showed a physical response and that was only a mild movement.

The discussion section of the paper is fascinating. The absence of physical reaction to the incision is seen as analogous to a similar absence of reaction to *Shechita* in cattle reported by Temple Grandin [1]. It was accepted that 'the eye test has been criticised as a test for unconsciousness because it is more indicative of brainstem reflexive function, which may be present even though an animal is unconscious'[8]. This is despite the latter test having been misapplied to attack *Shechita* in large animals in earlier studies

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It was further acknowledged that the fact that Shechita is performed on one bird at a time is a good thing and the fact that each bird is definitely dead removes any later pain or fear at the time of shackling. The authors state (grudgingly) that: 'on balance, taking into account the entire process, including the removal of the birds from their crates, their behavioural responses to neck cutting, the time to bleed out and the avoidance of the need to shackle live birds, that the *Shechita* procedure is acceptable.'

Stunning and effects on poultry

Despite a long career in opposition to *Shechita*, Gregory in his 2005 review, notes that unrestrained poultry subjected to electrical stunning across the head only develop severe wing flapping, for which reason head-to-vent electrocution has been advocated [9]. The flapping causes accelerated depletion of muscle ATP and glycogen , pH decline, lactate accumulation and poverty of water holding capacity. Of course, with the calm, purposive handling of birds prior to *Shechita* the severe wing flapping (and the fractures that can accompany this) simply does not arise. On the topic of gas stunning, Gregory acknowledges that 'in the human, CO_2 induces a sense of breathlessness with dyspnoea.'

Buhr considers the effect of stunning and anaesthetic agents upon poultry for slaughter in terms of the levels of anaesthesia recognised by professional anaesthetists and originally categorised by Guedel in 1937[10]. He does mention the 'possibility of the occurrence of electrical immobilization, retaining the ability to sense and perceive pain but unable to respond to stimuli, can occur if the electrical current path does not reach the brain of the subject.'

Massey University Programme of EEG based research

The most recent work on un-stunned slaughter (but not actually *Shechitá* or Halal slaughter) carried-out at Massey University and reported in the NZ Veterinary Journal in 2009 is an example of research that is deeply unsound, yet is being hugely over-interpreted.[11,12,13]

They have set out to establish a biological marker (spectrally analysed EEG) through which the pain effects of a neck incision can, it is claimed, be distinguished from the effects of a precipitous fall in cerebral blood flow. After this comes the paper that shows that a *shechita*-like cut produces a change akin to that of the supposed pain response and then comes a paper to show that stunning can put it all right. Thus the objective of the overall exercise is achieved, with the apparent endorsement of science.

A list of just some major concerns about the conduct of their experiments is shown below:

- the knife described is too short and bears no comparison to equipment used for *Shechita*
- the actual slaughter and restraint methods are poorly described and questionable
- the "special equipment" is not shown
- there is a lack of detail about the incision, its positioning and delivery, which in *Shechita* is precisely and carefully defined
- the head holder also does not seem to be doing the job properly, probably allowing too much movement
- the training and qualifications of the slaughter man is not given
- like so many of these papers, it does not give enough detail about the non pre-stunned slaughter (or un-stunned slaughter as they call it) experiment to determine what really is happening, which violates the basic scientific principle that the work must be repeatable by others!
- if this project is really about "un-stunned slaughter" unrelated to religious slaughter why is religious slaughter mentioned so frequently in the paper?
- the whole issue of the "sham cut" feels more like a negative control, i.e., what happens with minimal pressure. But the impact of a lot of pressure with no cutting is never addressed. The difference between the use of a broomstick (used to stimulate the

anterior neck as a sham condition) and the *Shechita* incision using its fine instrument without pressure makes a nonsense of a most important part of the whole project

- The whole issue of sharpening of knives is a major part of a *Shochet's* training. The *chalaf* of the *Shochet* is a precision instrument designed specifically to deliver a sensation-free incision and it is constantly examined and maintained.
- The heart rate reading very high in the first paper and much lower in the other two papers, suggesting that these animals were more stressed, it is hard to understand why that should be the case if the animals were not conscious?
- Even the authors admit that anaesthestic agent might have specific and important effects.
- the papers are extremely sloppy about how the words unconsciousness, insensibility, and undoubted insensibility are used, allowing much distortion of the discussion. The papers never actually establish an unconsciousness point, where it is accepted that the animal would not feel pain. According to the EU and common vocabulary, when the animal drops, it is unconscious and doesn't feel pain.

However, it is even more important to put on record that this series of studies is methodologically unsound, for a number of key reasons:

1. EEG recording electrodes have a very limited field of recording and the set up used by the MG was well away from the brain structures of pain signalling processing (PSP).
2. EEGs have poor spatial specificity and could never provide definitive evidence of pain signal processing even if they had recorded over the relevant temporal lobe structures.
3. EEG signals were obtained in the anaesthetised state which (by definition) induces a functional disconnect between pain signalling pathways and the higher cortical structures of awareness. Thus, cortical EEG cannot be used to reflect PSP.
4. The three derived Quantitative EEG (Q-EEG) values used by the MG are over simplistic, subject to confounding errors and are not used in modern Q-EEG literature.

5. The data sampling windows used by the MG were too short to provide meaningful Q-EEG frequency resolutions for any of the important frequencies they were trying to prove changes in and were presented without statistically derived confidence intervals.
6. Using these small windows facilitated the MG to use a flawed technique of 'rolling comparisons' to artificially generate a statistical difference from a single animal to prove that a blade incision of the neck induces a noxious response. This approach should be considered misleading.
7. The frequency shifts charted by the MG to qualitatively provide evidence of PSP were so small that they are clinically meaningless.
8. Q-EEG techniques always require a comparison with the original 'raw EEG' they are derived from. The lack of provision of these traces in all but one of the MG papers is highly suspicious.

Further criticism of individual aspects of each of the MG papers is currently being prepared for publication by Freilich et al.

Conclusion

Much work has been done to construct a scientific case against religious slaughter, but when viewed with an appropriately critical stance, the science is simply not reliable. There are numerous unfounded assumptions, methodology is very imprecise, the biological markers recently selected are extremely non-specific and the overlap between positive and negative responses between groups is considerable. Finally, the interpretation of the data and conclusions drawn are most unreasonable. Overall this is a very poor basis on which to formulate policy, when compared to the reliability, durability and intrinsic humaneness of *Shechita*.

[1]Grandin T. Euthanasia and slaughter of livestock. *J Am Vet Med Assoc* 1994; **204**: 1354-1360
[2] Gregory NG. Recent concerns about stunning and slaughter. *Meat Sci* 2005; 70: 481-491.
[3]Anil MH.,Mckinstry JL, Gregory NG, Wotton SB & Symonds H. Welfare of calves. 1. Investigations into some aspects of calf slaughter. Meat Science 1995; 41:101-112
[4]Anil MH.,Mckinstry JL, Gregory NG, Wotton SB & Symonds H. Welfare of calves. 2. Increase in vertebral artery blood flow following exsanguinations by neck sticking and evaluation of chest sticking as an alternative slaughter method. Meat Science 1995; 41:113-123
[5]Rosen SD. Physiological insights into Shechita. *Veterinary Record* 2004; 154, 759-765
[6] Anil MH, Yesildere T, Aksu H, Matur E, McKinstry JL, Weaver HR, Erdogan O, Hughes S, Mason C. Comparison of Hala slaughter with captive bolt stunning and neck cutting in cattle: exsanguination and quality parameters. Animal Welfare 2006; 15: 325-330.
[7] Barnett JL, Cronin GM, Scott PC. Behavioural responses of poultry during kosher slaughter and their implications for the birds' welfare. *Vet Rec.* 2007; 160: 45-49
[8] Gregory NG. The physiology of electrical stunning and slaughter. In: Humane slaughter of Animals for Food. Potters Bar UFAW 1987; 3-14.
[9]Savenije B, Schreurs FJG, Winkelman-Goedhart HA, Gerritzen MA, Korf J and Lambooji E. Effects of feed deprivation and electrical, gas and captive needle stunning on early post mortem muscle metabolism and subsequent meat quality. *Poultry Sci* 2002; 81: 561-571.
[10]Guedel AE. Stages of anaesthesia.Inhalation anaesthesia.London Macmillan 1937: 10-13.
[11] Gibson, T et al. Components of electroencephalographic responses to slaughter in halothane-anaesthetised calves: effects of cutting neck tissues compared with major blood vessels. *New Zealand Veterinary Journal* , 2009; 57(2), 84-89
[12]Gibson, T et al. Electroencephalographic responses of halothane-anaesthetised calves to slaughter by ventral-neck incision without prior stunning. *New Zealand Veterinary Journal* , 2009; 57(2): 77-83.

[13]Gibson, T et al. Amelioration of electroencephalographic responses to slaughter by non-penetrative captive-bolt stunning after ventral-neck incision in halothane-anaesthetised calves. *New Zealand Veterinary Journal.* 2009; 57(2): 96-101.

Physiological insights into *Shechita*

S. D. ROSEN

The Government recently announced that it intends to reject a recommendation by the Farm Animal Welfare Council that all animals should be stunned before slaughter (see *VR*, April 10, p 446). In this Viewpoint article, Dr Stuart Rosen discusses physiological aspects of *Shechita*, the Jewish method of religious animal slaughter. He outlines the religious context and describes the act of *Shechita*. He discusses the scientific literature on the behavioural responses to *Shechita* as well as neurophysiological studies relevant to the assessment of pain, and concludes that *Shechita* is a painless and humane method of animal slaughter.

THE purpose of this paper is to review the Jewish religious method of animal slaughter, *Shechita*, from a physiological point of view. Much of the data presented on scientific aspects of *Shechita* has been known for decades, although a number of new perspectives are included. To illustrate the principles, and make the process more comprehensible, a number of analogous human clinical scenarios are also considered. The author's principal research involvement in the topic of pain has been through the exploration of the neurophysiology of angina pectoris as a model of visceral pain (see, for example, Rosen and others 1994, 1996, 2002).

As a preamble, it should be stated that the reason for the Jewish observance of *Shechita* is that it is a basic commandment, conveyed via the Oral Law and dating back to the time of Moses. *Shechita* is a fundamental religious practice and constitutes the only method of animal slaughter permissible according to the traditional body of Jewish law, the *Halacha*. *Shechita* is, in fact, part of a broad range of legislation in the *Halacha* that promotes kindness to animals. Examples of this include: the injunction that animals are to rest on the Sabbath (Exodus XX 10); the interdiction against ploughing with an ox and an ass together (their natural powers being unequal) (Deuteronomy XXII 10); the injunction to send away a mother bird before removing eggs from a nest (Deuteronomy XXII 6); the prohibition against muzzling an ox at the threshing floor (Deuteronomy XXV 4); animals to be with their mother for (at least) the first seven days of their lives (Leviticus XXII 27); no slaughter of a mother animal and its offspring on the same day (Leviticus XXII 28); the need to reload an overloaded animal (Exodus XXIII 5, Deuteronomy XXII 4); and the obligation to feed one's animals before feeding oneself (Deuteronomy XI 15). It should be noted that Jewish people regard themselves as culpable within their religious law if their actions cause animals to suffer. Thus, consistent with the halachic legislation on other aspects of animal welfare, *Shechita* is embraced as a painless and rapid method of slaughter.

Because it is the only religiously permissible method of animal slaughter for Jews, moves to undermine the Jewish people's ability to perform *Shechita* have implications with regard to rights to religious expression. Historically, attacks on *Shechita* have not been based on prima facie scientific objections to its effects. For example, *Shechita* was banned in Germany in 1933, despite having been widely endorsed throughout the scientific community in 1932. This and other legislative aspects of *Shechita* were discussed extensively by Munk and others (1976).

Veterinary Record (2004) **154,** 759-765

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ACT OF SHECHITA

Shechita is the act of slaughtering an animal by a perfectly clean incision through the structures at the front of the neck – the trachea, oesophagus, carotid arteries and jugular veins.

Before *Shechita*, the animal has to be fit and healthy and capable of independent life. This last point, in addition to the fact that the act of *Shechita* must be the effective cause of the animal's death, underlies the unacceptability of stunning before *Shechita*, according to the *Halacha*.

Shechita is performed using a *Chalaf* (*Shechita* knife) (Fig 1). This is honed to an exquisite sharpness, comparable to that of a surgical knife, and it is repeatedly checked between each animal to avoid any imperfections. The name of the knife, *Chalaf*, is derived from the Hebrew verb 'to change', since it effects a change in the state of the animal from being forbidden as food while alive to being permitted for consumption after *Shechita*.

There are a number of key halachic considerations in this act: *Shehiya* – there should be no interruption of the incision; *Derasa* – there should be no pressing of the blade against the neck (this would exclude the use of a guillotine); *Halada* – the blade should not be covered by the hide of cattle, wool of sheep or feathers of birds (and therefore the blade has to be of adequate length); *Hagrama* – the incision has to be at the appropriate site on the neck, in effect that which permits the severance of the neck structures as quickly and as neatly as possible; and *Ikkur* – there must be no tearing of tissues.

Each of the five halachic considerations has important and positive practical implications. Grandin (1994) specifically highlighted the importance of using an instrument of exquisite sharpness and adequate length, swiftly applied and with avoidance of the wound closing over knife. Together, these factors are a major contribution to the efficacy of *Shechita* as a method of combined stun and slaughter.

Subsequent to the act of *Shechita*, certain other procedures are mandatory, such as the covering of the blood of poultry or game with earth or ash (*Kissuy HaDam*), the removal of forbidden fat (*Heleb*) from the mesenteric, pararenal and other areas, and the removal, via the koshering process, of the residual blood in the meat. (Koshering involves the soaking of the meat for prescribed periods of time and the application of substantial amounts of coarse salt to draw out the blood. Roasting with an open flame can also be employed; this is obligatory in the case of liver. This is discussed in detail by Grunfeld [1972].)

Restraint of larger animals

To maintain optimal positioning, larger animals (mostly bovids) are led into a restraining pen in which the animal is held while *Shechita* is performed. Grandin (1994) has described in detail designs and operational procedures for this device.

It is important to note that the restraint is not a 'crush'. Significant features of the upright pen, recommended by the Farm Animal Welfare Council in 1985, are a belly-plate designed to lift and support the animal at slaughter and a chin lift and poll stop. These features were made law in 1992. An advantage in the use of a chin lift is the prevention of re-occlusion of the carotid arteries. This is important in allowing a very rapid loss of cerebral function.

PRACTITIONER OF SHECHITA – THE SHOCHET

The act of *Shechita* is performed by a *Shochet*. The *Shochet* studies intensively for many years and must have a thorough knowledge of animal anatomy, pathology and the laws of *Shechita*. The *Shochet* must be licensed by both a local authority and by the Rabbinical Commission for the Licensing of *Shochetim*. The commission is a statutory body established by Parliament and now governed by Schedule 12 of the Welfare of Animals (Slaughter or Killing) Regulations 1995. Every *Shochet* is examined annually by this commission and must apply for renewal of his licence every 12 months. Such rigorous training, supervision and continuous professional assessment is much more arduous than the lot of the general slaughterman. The latter is licensed to practise for life, provided he or she does not contravene any animal welfare regulations.

PHYSIOLOGY OF SHECHITA

Brain anatomy and physiology

Although it comprises only about 2 per cent of the body's weight, the brain receives 20 per cent of cardiac output (Poole-Wilson 1989). It is sensitive in its requirements for oxygen and is generously supplied, mostly via the carotid arteries. A lesser supply may come via the vertebral arteries. The anastomosis between the two internal carotid arteries as well as with the vertebral arteries forms a 'ring road' at the base of the brain. In cows this is the rete mirabile; in sheep, by way of contrast, the vertebral arteries are rudimentary, petering out before they reach the brain (Levinger 1995a). In man, this arrangement is the Circle of Willis.

The effect of having an arterial 'ring road' at the base of the brain is that if there is a stenosis or occlusion of one of the cerebral arteries, the brain region supplied by that vessel can still obtain adequate perfusion via one of the other vessels. However, this is not the case if the carotid arteries are opened, in which case blood flow follows the route of lowest resistance.

Autoregulation

Blood flow through the brain is kept at a steady level, despite quite wide variations in the prevailing blood pressure, through autoregulation (Haddy and Scott 1977). In the microcirculation of the brain, vessels dilate or constrict to keep tissue perfusion constant. However, there are limits to this corrective mechanism and (at least in man) autoregulation fails if blood pressure falls by more than 50 per cent (Kleinerman and others 1958, Njemanze 1992).

Cerebral blood flow and consciousness

In clinical cardiological practice, a rare but (fortunately!) usually reversible complication of routine diagnostic coronary angiography is the provocation of ventricular tachycardia or ventricular fibrillation. When this happens, the collapse in cardiac output immediately leads to a failure of brain perfusion and the patient rapidly loses consciousness (Rossen and others 1943). The whole process can, in these circumstances, be timed very precisely by following the electrocardiogram (ECG). It takes less than five seconds for a patient lying on his or her back to lose consciousness during a cardiac arrest. An even quicker loss of consciousness would be expected in a standing individual because of the need for a greater driving pressure to propel blood up to the brain.

Not surprisingly, this is exactly what one finds when performing head-up tilt-table testing for the investigation of patients with syncope (Grubb and others 1992). After an appropriate (approximately 50 per cent) fall in cardiac output, loss of consciousness follows in less than five seconds.

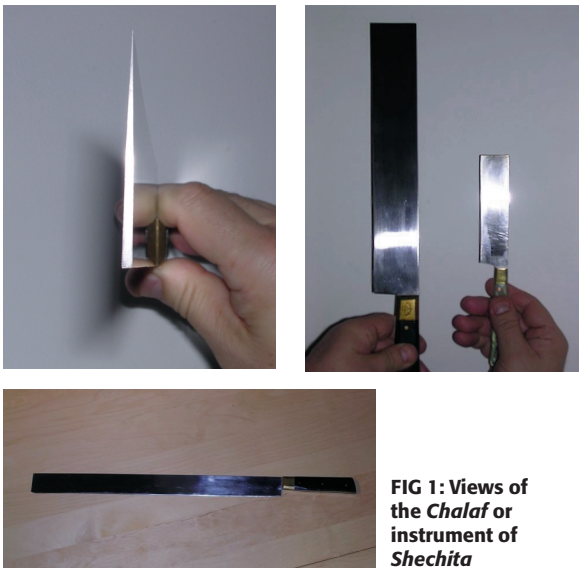

FIG 1: Views of the *Chalaf* or instrument of *Shechita*

Another medical model germane to this discussion is the acute management of severe hypertension. It is of the greatest importance not to bring the blood pressure down too precipitously, otherwise patients are at a high risk of stroke because of underperfusion of the brain (Diringer 1993).

The cerebral regions most likely to be affected in all of these examples of precipitous loss of brain perfusion are the cortical areas (Noell and Chinn 1950).

IMMEDIATE PHYSIOLOGICAL EFFECTS OF THE SHECHITA INCISION – EXPERIMENTAL DATA

Cerebral perfusion

After the *Shechita* incision, blood loss is extremely rapid. In Dukes's classical studies (Dukes 1958), 33 per cent of the animal's entire blood volume was lost in approximately 30 seconds and 50 per cent within one minute. The decrease in blood flow to the brain has been measured by means of a manometer placed in the internal maxillary artery, and the fall in blood pressure in the brain has been shown to be greater than the fall anywhere else in the arterial tree (Spörri 1965). As a consequence, flow through this artery was zero after *Shechita*. These rapid and important falls in blood pressure were associated with loss of consciousness within a few seconds.

Since the carotid arteries are severed at *Shechita*, blood flows out of them at a great rate. This applies not only to the blood that passes from the aorta, up the brachiocephalic trunk to the carotid arteries, but also to the blood that runs through the brachiocephalic trunk to the vertebral arteries. In the case of carotid severance (as in *Shechita*) blood flowing through the vertebral arteries follows the route of lowest resistance, which is, in fact, back to the distal stump of the carotid (Fig 2). The importance of restraint for post-*Shechita* bleed out might also explain the variable period to loss of function reported in an experiment in cattle by Blackmore (1984). In this study, there was a manual cut of exteriorised neck vessels, but 'after incision of the neck, all restraint was immediately released'. This could produce re-occlusion of the vessels, which should not occur in *Shechita*.

With regard to experimental studies looking at the relative contribution of the cerebral vessels to overall perfusion of the bovine brain, Levinger (1976) examined changes in regional brain blood flow after *Shechita*, using a dye dilution method. Dye was injected through a catheter directly into the right and left ventricular chambers immediately before *Shechita*. Although, with microscopic investigation, appreciable amounts

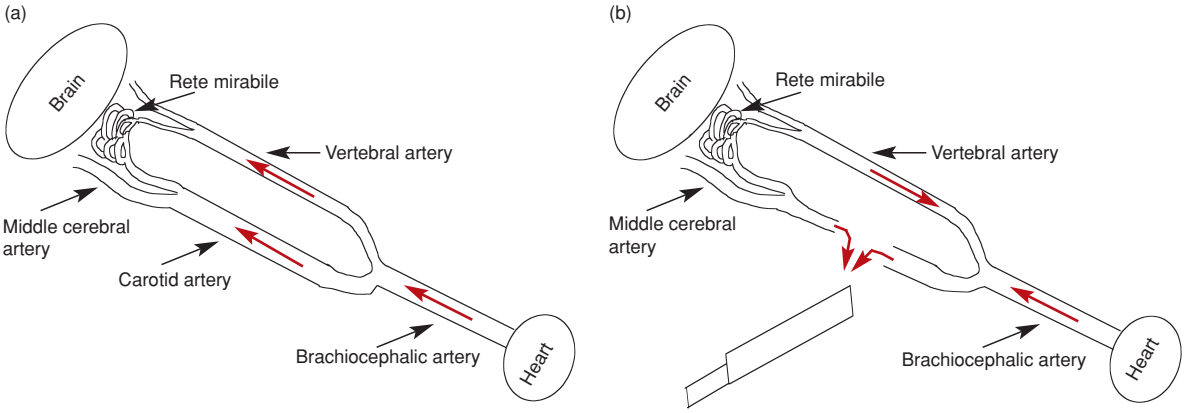

FIG 2: Effect of the *Shechita* incision on blood flow through the main arteries to the brain. (a) Before the incision and (b) after the incision. Note that blood flow is in the direction of least resistance

of the stain could be shown in the liver and kidneys, little, if any, could be seen within the brain, and certainly too little to be compatible with the support of brain function.

In contrast, Blackman and others (1986) looked at possible differences in blood supply to the cerebral cortex between sheep and calves during slaughter. They reported that methylene blue was demonstrable in the brain of calves more than 100 seconds after bilateral carotid severance. However, the slaughter was not performed through *Shechita*.

One reason that some of the data cited appear to be in conflict may be that the actual circumstances of the studies are not strictly comparable (*Shechita* v a non-*Shechita* cut). There have also been confusing (and misguided) attempts in the past to compare *Shechita* to experiments in which the carotid arteries were clamped (Levinger 1961). After carotid clamping, drowsiness and swaying are observed and the animals pass urine and faeces. With continuation of the clamping, a recovery of equilibrium is achieved after about one-and-a-half minutes. In this case, the maintenance of brain function is presumably by means of blood flowing through the vertebral arteries.

More recently, Shaw and others (1990) reported on the role of the vertebral arteries in maintaining spontaneous electrocortical activity after electrical stunning and slaughter in calves. When the blood supply to the brain was severely reduced by the carotid arteries being clamped to mimic a clot (rather than severed), then even when all available blood was effectively forced through the brain via alternate pathways, cortical function could not be maintained or be re-established. The time to isoelectric electrocorticogram (ECoG) in these calves was not different from that in calves which had undergone carotid severance after earlier surgical ligation of the vertebral arteries.

In contrast, after the *Shechita* incision in cattle, there exists a low-resistance route through which blood in the vertebral arteries exits. As noted above, this does not apply to sheep, in which the vertebral arteries terminate before reaching the brain.

Cardiac activity

The heart continues to beat for a few minutes after the *Shechita* incision. For the first minute, the force of contraction is maintained as venous blood from the periphery of the body continues to flow back to the heart despite the arterial blood being lost through the severed carotids. Within approximately one minute, lack of venous return leads to a reduction in cardiac preload. Cardiac contractility is diminished because of this, as well as the reduction in oxygen reaching the myocardium. In contrast with the cardiac arrest immediately provoked in head-back electrical stunning, the fact that, after *Shechita*, the heart can continue to beat for a few minutes means that this method of slaughter contributes very positively to exsanguination. This has positive health and hygiene implications.

In summary, the collapse in the arterial blood pressure that follows on from the severance of the carotid arteries at *Shechita* causes a dramatic fall in cerebral perfusion. The cerebral cortex is particularly sensitive to this (see, for example, Noell and Chinn 1950). Consciousness is lost rapidly (within approximately two seconds) and irreversibly.

EXPERIMENTAL DATA ON THE EFFECTS OF SHECHITA ON CEREBROSPINAL FLUID PRESSURE

Cerebrospinal fluid pressure

The brain is a soft and hollow organ and its usual shape and structure are, to an extent, maintained by the pressure of cerebrospinal fluid (CSF) within the cerebral ventricles (De Lange 1977, Walton 1993). The shape of the brain is also maintained by the gradient between the relatively high pressure of the arterial blood flowing into it and the lower pressure in the veins draining it. The venous pressure, in turn, also has an influence in maintaining the correct pressure in the CSF (Cohen and others 1970).

Sudden changes in these pressures can have a devastating effect on brain function (Levinger 1970). A good human model of this is the patient with hydrocephalus (Hong and Pickard 1996), for example, due to obstruction of the flow of CSF from the cerebral ventricles to the outer surface of the brain. The only effective treatment is implantation of a shunt – usually between the brain ventricles and one of the great veins or the right atrium. The shunt contains a valve to prevent reflux of blood to the brain. There are numerous documented cases of shunt obstruction, which produces an increase in brain pressure, headache and then diminished consciousness (Kestle and others 2000). Less commonly, there are descriptions of leaks of the shunt valve, causing brain irritability followed by collapse and unconsciousness. Other causes of reduction in CSF pressure are also recognised (Khurana 1996).

Pressures within the brain ventricles

Levinger (1976) has shown by direct measurement that after *Shechita* the CSF pressure within the brain ventricles falls even more rapidly than the blood pressure within the internal maxillary artery. This is because of the collapse in jugular venous pressure, without replacement by arterial blood. The maintenance of brain structure is impaired as a kind of 'implosion' of the brain occurs.

BEHAVIOURAL RESPONSES TO THE SHECHITA INCISION

Direct observation of an animal's responses before, during and after *Shechita* are both fascinating and important, especially since, in the assessment of potentially painful experiences by animals, pseudoaffective responses are the major indication of how stressful or painful such experiences are.

The free animal before *Shechita*

In accordance with the *Halacha*, *Shechita* is performed on one animal at a time. Cattle and sheep are sentient creatures; however, there is no sign that the animals are frightened of impending death since they continue to ruminate normally.

Handling before *Shechita*

There is no direct evidence of behavioural signs of stress in anticipation of *Shechita*. The restrained animal is calm and still before the act of *Shechita*, probably due to calm and purposive handling. A further pointer to the efficacy of restraint in this fashion is the fact that it has been adopted by a number of non-*Shechita* slaughtermen.

Immediate response to the *Shechita* incision

Grandin (1994) reported that before *Shechita*, at the moment of the incision, and immediately after *Shechita* there was no flinching and no reflex defence response suggestive of any sensation of pain. Bager and others (1992) also observed a lack of flinching. It can be deduced, therefore, that the incision itself is not painful. The animals studied by Grandin were in a restraining pen, but not constrained to the extent that such movements would have been impeded. The lack of a response to the *Shechita* incision is in contrast to the observable effects of inflicting such painful stimuli as ear tagging or, possibly, captive bolt stunning. Reports such as that of Grandin are of particular importance, being studies of cattle, the species about which greatest concern has been expressed in relation to pain perception.

Laboured respiration

After about 30 seconds, a strained and noisy form of slow breathing supervenes, related to muscular spasms of the diaphragm or unusual signals to the respiratory muscles from the hypoxic brain. Unsurprisingly, this does not improve tissue oxygenation, and this form of breathing has also been observed after severance of the head.

It has been asserted, without any supporting data, that the very fact of breathing through the severed trachea must per se be very distressing. We know from the many human tracheostomy cases that this is untrue; in addition, in an animal that has undergone *Shechita*, consciousness will have been lost long before it could be aware that it is breathing through a severed trachea.

Muscular spasms

Also after about 30 seconds, strong muscular spasms frequently cause the limbs to thrash violently (Levinger 1995b). These movements are in no respect at all a conscious reaction to pain; they are reflexes due to hypoxia of the spinal cord causing abnormal efferent signals to the muscles and can be abolished by electrical depolarisation of the spinal cord (Gilbert and others 1984). This phase can last for up to four minutes.

THE ISSUE OF PAIN

The nature of pain

The crucial animal welfare question in relation to methods of animal slaughter is whether the methods cause pain. It is not straightforward to answer this question, for a number of reasons. The first is that pain itself is not easy to define (Wall 1989), beyond it being an unpleasant sensation or awareness in response to a physical or mental stimulus. Secondly, it is an intrinsically subjective experience. Any notion that one might have of pain in another person or animal is dependent on one's imagining how one would feel in that situation and projecting the same on to the other person or animal. Thirdly, in the absence of an articulate expression of feelings, which is clearly impossible in the case of animals, one can only infer the presence of pain by observation of behavioural responses (for example, withdrawal from the stimulus, efforts to escape from the stimulus, cries or other vocalisations, etc) or through clear neurophysiological data, if such are available.

Neurophysiological basis

The hope that scientific methods could overcome these limitations, for example, through physiological measurements of an animal's responses, remains to be realised, not least because the issue is extremely complex and the data are difficult to interpret. More obvious parameters such as increases in heart rate or blood pressure due to activation of the body's sympathetic ('fight/flight') system are non-specific. This is also the case for neurohumoral markers such as plasma cortisol, or β-endorphin.

A few key points are generally accepted; for example, a functioning, conscious brain is necessary for the perception of pain. Studies have been performed using positron emission tomography, which can measure regional cerebral blood flow as an index of neuronal activation, to investigate brain activation in live, awake humans. These studies have shown that, within the brain, the cerebral cortex is essential for the perception of pain, whether the origin of the pain is the skin surface (Jones and others 1991), the oesophagus (Aziz and others 1997) or the heart (Rosen and others 1994).

In addition, the painful stimulus from the periphery has to be adequate to activate the pain pathways. Considering the situation with *Shechita*, the starting point is, indeed, an animal which is conscious up to the moment of the act of *Shechita*, but the drastic and rapid fall in cerebral blood flow immediately after the *Shechita* incision inactivates the cerebral cortex by depriving it of its blood supply, leading to a rapid loss of consciousness. Also, the exquisite sharpness of the *Chalaf*, coupled with the smoothness of the incision, mean that, as for a surgical incision, there is minimal stimulation of the incised edges, typically below a level adequate to activate the pain pathways. The latter is analogous to the frequent experience of surgeons who have cut themselves in the course of an operation and only noticed it well after the event. It will also be recalled that proper attention to the halachic requirements during *Shechita* also contributes to the lack of stimulation of the incised edges.

A medical event relevant to this discussion is the experience of stroke. Regardless of the mechanism of stroke (whether thromboembolic or haemorrhagic), they are painless, as attested to by patients who retain or regain the power of speech after a stroke.

Data from electrophysiological studies

Brain electrical activity has been assessed classically from the surface of the scalp – the electroencephalogram (EEG) (Goetze and others 1959, Modarres 2000), and, more invasively, by means of recording electrodes on the brain surface – the ECoG. A number of waves are recognised on the EEG. The dominant wave during wakefulness is the α wave, an almost sinusoidal discharge with a frequency around 10 Hz and amplitude between 0 and 100 mV. The α rhythm is inhibited by visual input and concentration with effort. As wakefulness is lost, for example, during anaesthesia, the α waves give way to β and γ waves. A β rhythm was noted between three and seven seconds after the *Shechita* incision. This represented a shift from low

amplitude, high frequency waves to high amplitude, low frequency. An isoelectric state (flat trace) supervened in 15 to 30 seconds in sheep and goats (Nangeroni and Kennet 1963). In the cattle studied by Nangeroni and Kennet (1963), there was a shift in wave form to high amplitude, low frequency, with loss of consciousness in approximately three seconds. An isoelectric trace was displayed in less than 25 seconds. There were, however, disparate responses to carotid clamping in one of the calves, suggesting an abnormal anatomical variant in the cerebral blood supply in this animal.

Schulze and others (1978) studied 25 sheep and 15 calves and saw no effect of the *Shechita* incision on the raw EEG trace. The time to an isoelectric state was less than 13 seconds in the sheep and less than 23 seconds in the calves.

In more recent times, the use of raw EEG data, especially the measurement of time to an isoelectric state, has come in for much criticism for several reasons. First, the anaesthetised patient does not have a flat EEG and yet is (hopefully!) not sensible to pain. Most dramatically, EEG activity can even be demonstrated in severed heads (Swaab and Boer 1972, Mayevsky and Chance 1976). Since these decapitated animals are clearly dead, it can be deduced that the mere presence of an EEG trace certainly does not equal consciousness.

It is noteworthy that after captive bolt stunning the relevant changes in EEG frequency might also take at least 25 seconds in cattle (Fricker and Riek 1981). Thus, if insensibility were to be defined on this basis, it would not be achieved instantly by captive bolt stunning (Daly and others 1988). On this basis, the requirement stated by a number of the critics of *Shechita*, that the stunning method of choice is the one that is first to produce an entirely flat EEG, is irrelevant.

Daly and others (1988) assessed brain function in adult cattle after conventional captive bolt stunning compared to *Shechita*. The measurement of brain function was, in terms of visual and somatosensory evoked potentials, unlike the simpler reports of raw EEG data described above. These authors reported that, compared with captive bolt stunning, the act of *Shechita* led to greater variability in the time to loss of evoked responses, between 20 and 126 seconds (mean 77 seconds for somatosensory and 55 seconds for visually evoked responses), with spontaneous activity lost between 19 and 113 seconds (mean 75 seconds).

These data have been the focus of much attention, because, within welfare considerations, the length of time during which an animal *could* potentially experience pain has (rightly or wrongly) been regarded as a surrogate of the relative risk of distress associated with the particular technique of slaughter. In this context, it is important to note the caveats of the authors themselves: 'The evoked responses do not represent a conscious awareness of the stimulus but are produced by neural activity at a rudimentary level which precedes conscious awareness. This is best demonstrated by the fact that evoked responses can be recorded in anaesthetised animals.' In addition, as noted by Levinger (1995c), when Kallweit and colleagues compared the time from bleeding until the isoelectric line in both methods of slaughter, the length of time was greater after carotid severance without prestunning. However, if it is borne in mind that the length of time during which an animal could potentially experience pain is from the beginning of the shot with the captive bolt, not at the bleeding cut after the shot, then the time from *Shechita* to the isoelectric line is actually shorter.

A further refinement in the analysis of EEG data has been the application of techniques of time and frequency domain analysis, which are already well established in the study of heart rate variability in man. Bager and others (1992) described a study of calves in which a fast Fourier transform had been applied to the raw EEG data and possible correlations with metabolic markers of brain failure after slaughter were examined. They assessed ECoG and metabolic markers (PO_2, PCO_2, pH, lactate and glucose levels in brain arterial and venous blood) in groups of calves which were either stunned, recovered for 80 to 100 minutes and then stunned and slaughtered; or stunned and immediately slaughtered; or slaughtered without stunning (although not by *Shechita*, but rather by a 'gash cut' that severed the jugular veins, the common carotid arteries and the vagosympathetic trunks at the level of the trachea). Their findings included several of interest to the present paper, including that the head-only stun employed produced an epileptiform seizure lasting for between 22 and 29 seconds after the stun, which was probably responsible for the biochemical signs of substantially increased cerebral metabolism. They also found that after the unstunned gash cut, animals became insensible very quickly, that is, they showed a quick onset of high amplitude, low frequency waves, unless the carotid arteries re-occluded. The authors commented that 'simply using the amplitude of the ECoG, therefore, is insufficient to determine sensibility. A delayed attainment of an isoelectric ECoG also does not indicate that the animal is sensible.' In addition, no correlations were found between the indices of cerebral metabolism measured and the time to loss of (electrical) cortical function. There were other observations of interest, such as the absence of an increase in haemoglobin in the unstunned calves, which might suggest that changes in sympathetic activity were minimal in those calves. Bager and others (1992) commented that 'Slaughter without stunning, while mostly resulting in rapid irreversible loss of ECoG activity, may sometimes be associated with a period of low frequency activity when a residual blood supply is maintained.' As noted above, when the act of *Shechita* is performed correctly, such a residual blood supply will *not* be operative.

In broader terms, it can be seen that time to insensibility is not actually being measured in any of the above experiments, let alone time to loss of any possible feeling of pain. The measurement that has been made is time to 'brain failure'. Raw EEG and ECoG data can indicate undoubted consciousness and undoubted insensibility, but not the start of insensibility. There is little likelihood that the more sophisticated mathematical derivatives of the raw data would yield much improvement because the techniques are still nonspecific – there would still be no way of knowing whether the change in the parameters being measured would be saying anything about a feeling of pain.

Exploration of the corneal reflex has also been applied to the study of pain perception in animals. In man it is well known that touching the cornea elicits a reflex involving the Vth cranial nerve that brings about a withdrawal from the stimulus or a closing of the eye (Pappworth 1984). The length of time until the disappearance of the corneal reflex has been considered by some to be a marker of the time to loss of consciousness. However, a more detailed consideration of the corneal reflex reveals that it is dependent not on the cerebral cortex, but on lower brain structures, particularly the brainstem. It is therefore quite possible to have an intact corneal reflex for a little while after the loss of the capacity to think or feel.

It follows that some stunning techniques, either through mechanical impact or electrical disturbance, will very likely affect function of subcortical structures and cause the corneal reflex to be lost a little quicker than *Shechita* (Nangeroni and Kennet 1963), in much the same way as an individual whose brain had been blown out would also fail to show rudimentary reflexes. After *Shechita*, the corneal reflex may indeed still be elicited for some 20 seconds, but consciousness will have been lost in less than three seconds.

STUNNING

In the course of discussing the physiological aspects of *Shechita*, reference has inevitably been made to stunning.

Stunning refers to the process of rendering an animal insensible before slaughter. It is often assumed, although with no positive proof having been adduced, that stunning is a kindness to the animal to be slaughtered and some use the phrase 'humane stunning'. There are a number of mechanisms of stunning, as described below.

Mechanical stunning

With this method, a severe blow is delivered to the head of the animal (Daly and others 1987), usually through the use of a captive bolt pistol. When fired, the central metal core of this device emerges a short distance. Despite the small distance, the bolt emerges with considerable speed so that its momentum, and therefore the force of the blow to the head, is very great. The captive bolt method requires accurate placement of the pistol on the animal's head, and a degree of restraint of the animal is necessary to facilitate this. Captive bolt stunning, and, as described below, carbon dioxide stunning, entails massive sympathetic discharge, which might be taken to indicate a very large stress response (Mitchell and others 1988, Hartung and others 2002). As an aside, there have been recent suggestions that the captive bolt method of stunning may be associated with risk of transmission of infection, including prion diseases (Love and others 2000).

Electrical stunning

Electrical stunning causes insensibility in an animal by means of a large electrical discharge across its head. The electrical discharge is likely to achieve its effect by a number of means, the most likely of which is asphyxia due to paralysis of the respiratory muscles (Hillman 2003). Massive sensory stimulation is probable and this might be extremely painful (Sassoon 1956, Hillman 1993), although the paralysis of the motor system would mask important signs of distress.

Another mechanism of action of electrical stunning would appear to be the induction of a prolonged epileptiform seizure (Bager and others 1992). It is noteworthy that electric shock therapy has never had any application in human anaesthesia. On the contrary, in the one situation in which an electrical discharge through the brain is used therapeutically, that is, the treatment of depression by electroconvulsive therapy (ECT) (Gelder and others 1996), full general anaesthesia, including paralysing agents, has to be given first, because of the severe muscle damage and potential for fractures which occurred with the older, so-called unmodified, ECT.

Other methods

Other methods of stunning have been developed. The main one of these is that of narcosis – making animals sleepy to the point of being comatose – by their breathing carbon dioxide-enriched air. Carbon dioxide narcosis is almost exclusively used in poultry slaughtering. As with the other methods of stunning, its introduction was effected with no direct objective evidence of any reduction in distress on the part of the animal. There have, though, been many human physiological experiments on carbon dioxide rebreathing. Such studies have shown that, before subjects get to the sleepy phase of carbon dioxide intoxication, there is an extremely distressing, agitated phase during which the increase in inspired carbon dioxide provokes a severe and frightening air hunger (West 1990). There are data to suggest that turkeys stunned by this method also go through a similarly distressing phase before narcosis (Erhardt and others 1996), and carbon dioxide is undoubtedly irritating to the respiratory tract (Raj and Gregory 1993). Even if other gases, such as argon, are used for stunning, the same essential mechanism applies, namely deprivation of oxygen, and the same agitating air hunger effects would be expected, as in all other cases of asphyxiation.

The relevance to *Shechita* of this brief survey of stunning is as follows. It will be noted that, in the course of the first two types of stunning described, the nervous system is directly damaged, before the final act (sticking) which terminates the life of the animal. This unquestionably makes the animal a *Trefah* (that is, unfit for *Shechita* because of an existing injury or abnormality). Even in the case of any putative method of stunning which did not inflict direct damage to the nervous system, the stunned animal would be unable to be seen to stand up fit and well before its final dispatch, an essential halachic prerequisite.

It has been commented by some in discussions on animal welfare that, while it is accepted that there is no scientific evidence of *Shechita* being painful, prestunning is nevertheless desirable because the animal should be given 'the benefit of the doubt.' There is an assumption (even described by some as a 'tenet of belief') that stunning before slaughter is a kindness to the animal. The argument underpinning this has been said to be 'intuitive'. This, though, is an unreliable measure, to say the least. 'Intuitive' in this context' equals 'unscientific'; it might also equal 'irrational' or, worse still, 'untrue'. For example, intuitively one might imagine that in countries where the death penalty is applied, rendering a human being unconscious before execution by means of a massive blow to the head would be a painful and unacceptable method. The same could be said for electrical stunning or gaseous asphyxiation.

It is likely that one reason for the clamour for stunning in certain quarters is confusion of an aesthetic nature. Characterisation of *Shechita* as 'cutting an animal's throat', with descriptions of blood spurting from the neck or of the late muscular spasms, are unattractive, to say the least. However, to the uninitiated, coronary artery bypass surgery is also visually unappealing! In dealing with an issue as important as the potential suffering of animals, it is unacceptable that superficial aesthetic considerations should be allowed to cloud the argument.

CONCLUSION

In conclusion, after a review of the physiological issues involved and the experimental data, it is submitted that *Shechita* is a painless and effective method by which to stun and dispatch an animal in one rapid act.

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Religious slaughter and animal welfare: a discussion for meat scientists.

Meat Focus International - March 1994 pages 115-123
Published by : CAB International

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Both the Muslim and Jewish faiths have specific requirements for the slaughter of religiously acceptable animals. The major difference from the general practices in most countries is that the animals are not stunned prior to slaughter. It is important that meat scientists understand the implications of these differences. They need to critically consider the scientific information available about the effects of different slaughter practices on animals before reaching any judgements about the appropriateness of a particular form of slaughter. It is also important that they understand the importance of these practices to the people who follow these religious codes. We hope to discuss some information that may be useful in evaluating religious slaughter.

The Jewish dietary code is described in the original five books of the Holy Scriptures. The Muslim code is found in the Quran. Both codes represented major advancements in the respect for animals and their proper handling in ancient times. For example, the Jewish code specifically forbid the use of limbs torn from live animals and the slaughter of both a mother animal and her children on the same day.

One way to view the rather comprehensive legal system of the Jewish faith is spelled out in the paragraphs below. We feel this explanation may help others understand the degree of significance of these religious practices to those of the Jewish faith (Grunfeld, 1972).

> "And ye shall be men of holy calling unto Me, and ye shall not eat any meat that is torn in the field" (Exodus XXII:30)

Holiness or selfsanctification is a moral term; it is identical with...moral freedom or moral autonomy. Its aim is the complete selfmastery of man.

"To the superficial observer it seems that men who do not obey the law are freer than law-abiding men, because they can follow their own inclinations. In reality, however, such men are subject to the most cruel bondage; they are slaves of their own instincts, impulses and desires. The first step towards emancipation from the tyranny of animal inclinations in man is, therefore, a voluntary submission to the moral law. The constraint of law is the beginning of human freedom....Thus the fundamental idea of Jewish ethics,

holiness, is inseparably connected with the idea of Law; and the dietary laws occupy a central position in that system of moral discipline which is the basis of all Jewish laws.

"The three strongest natural instincts in man are the impulses of food, reproduction, and acquisition. Judaism does not aim at the destruction of these impulses, but at their control and indeed their sanctification. It is the law which spiritualises these instincts and transfigures them into legitimate joys of life."

We hope that the above quote suggests the importance of the kosher dietary laws to people of the Jewish faith. Similar religious philosophies underpin the Muslim requirements. Thus, the ability to carry out ritual slaughter is extremely important to people of these two faiths. The banning of such slaughter would certainly be viewed as a hostile act.

The actual reference to slaughter in the Jewish Holy scriptures is quite cryptic:

> "...thou shall kill of thy herd and of thy flocks, which the Lord hath given thee, as I have commanded thee..."(Deuteronomy XII:21)

Clearly it was assumed that people were familiar with the rules for kosher slaughter. These were a pan of the "oral code". Eventually these rules were written down in the series of volumes referred to as the Talmud as well as in other religious texts. The Talmud contains an entire section on slaughter and the subsequent inspection of animals to ensure that they are religiously "clean". The text includes detailed anatomical information in order to teach the religious Jew exactly what was to be done during slaughter and the subsequent post-mortem inspection.

The Muslim rules with respect to animals and slaughter are contained in the Quran. Blood, pork, animals dying due to beating, strangulation, falls, goring or other damage from animals and animals dedicated to other religions are all forbidden. Any Muslim may slaughter an animal while invoking the name of Allah. In cases where Muslims cannot kill their own animals, they may eat meat killed by a "person of the book", i.e., a Christian or a Jew. Again stunning prior to slaughter is generally not the practice . However, a non-penetrating concussion stunning prior to slaughter has received approval from some Muslim authorities. Work in the 80's in New Zealand led to the development of a very sophisticated electrical stunning apparatus that met a Muslim standard where an animal must be able to regain consciousness in less than a minute and must be able to eat within five minutes. Head-only electric stunning prior to Muslim slaughter is used in almost all sheep slaughter plants in New Zealand and Australia. Electric stunning of cattle is used in many New Zealand Muslim cattle slaughter plants and the practice is spreading to Australia. Meat from electrically stunned cattle and sheep is exported to middle eastern countries with stringent religious requirements. "Halal" slaughter in New Zealand and Australia may be carried out by regular plant workers while Muslim religious leaders are present and reciting the appropriate prayers. However, the larger Halal slaughter plants in Australia, New Zealand, and Ireland do employ Muslim slaughtermen. Muslim slaughter without stunning is forbidden in New Zealand. With Muslim slaughter in countries not using stunning, we are also concerned about the training given to the slaughtermen. More work is needed on training programs to teach proper sharpening of knives and to improve the actual slaughter techniques.

The Jewish religious codes require that allowed animals be slaughtered by a specially trained Jewish male, while the Muslims prefer that allowed animals be slaughtered by a person of that faith. In the case of the Jewish dietary laws, a specially trained person of known religiosity carries out the slaughter. This person, the "shochet", is specifically trained for this purpose. He is trained to use a special knife, called the "chalef", to rapidly cut in a single stroke the jugular vein and the carotid artery without burrowing, tearing or ripping the animal. The knife is checked regularly for any imperfections which would

invalidate the slaughter. This process when done properly leads to a rapid death of the animal. A sharp cut is also known to be less painful .

Need for objective evaluation

Given the importance of religious slaughter to people of these two major faiths, it is important that scientists must be absolutely objective when evaluating these practices from an animal welfare standpoint.

Evaluation of religious slaughter is an area where many people have lost scientific objectivity. This has resulted in biased and selective reviewing of the literature. Politics have interfered with good science. There are three basic issues. They are stressfulness of restraint methods, pain perception during the incision and latency of onset of complete insensibility.

Restraint

A key intellectual consideration is separation of the variable of restraint stress from the animal's reaction to the slaughter procedure. Stressful or painful methods of restraint mask the animal's reactions to the throat cut. In North America some kosher slaughter plants use very stressful methods of restraint such as shackling and hoisting fully conscious cattle by one rear leg.

Observations of the first author indicate that cattle restrained in this manner often struggle and bellow and the rear leg is bruised. Bruises or injures caused by the restraint methods (or from any other cause) would be objectionable to observant Jews. In Europe, the use of casting pens which invert cattle onto their backs completely mask reactions to the throat cut. Cattle resist inversion and twist their necks in an attempt to right their heads. Earlier versions of the Weinberg casting pen are more stressful than an upright restraint device (Dunn 1992). An improved casting pen, called the Facomia pen, is probably less stressful than order Weinberg's pens but a well designed upright restraint system would be more comfortable for cattle. Another problem with all types of casting pens is that both cattle and calves will aspirate blood after the incision. This does not occur when the animal is held in an upright position.

Unfortunately some poorly designed upright American Society for the Prevention of Cruelty to Animals (ASPCA) restraint boxes apply excessive pressure to the thoracic and neck areas of cattle. In the interest of animal welfare the use of any stressful method of restraint should be eliminated. A properly designed and operated upright restraint system will cause minimum stress. Poorly designed systems can cause great stress. Many stress problems are also caused by rough handling and excessive use of electric prods. The very best mechanical systems will cause distress if operated by abusive, uncaring people.

In Europe there has been much concern about the stressfulness of restraint devices used for both conventional slaughter (where the bovine is stunned) and ritual slaughter. Ewbank et al., (1992) found that cattle restrained in a poorly designed head holder, i.e., where over 30 seconds was required to drive the animal into the holder, had higher cortisol levels than cattle stunned with their heads free. Cattle will voluntarily place their heads in a well designed head restraint device that is properly operated by a trained operator (Grandin 1992). Tume and Shaw (1992) reported very low cortisol levels of only 15 ng/ml in cattle during stunning and slaughter. Their measurements were made in cattle held in a head restraint (personal communication, Shaw 1993). Cortisol levels during on-farm restraint of extensively reared cattle range from 25 to 63 ng/ml (Mitchell et al., 1988; Zavy et al., 1992).

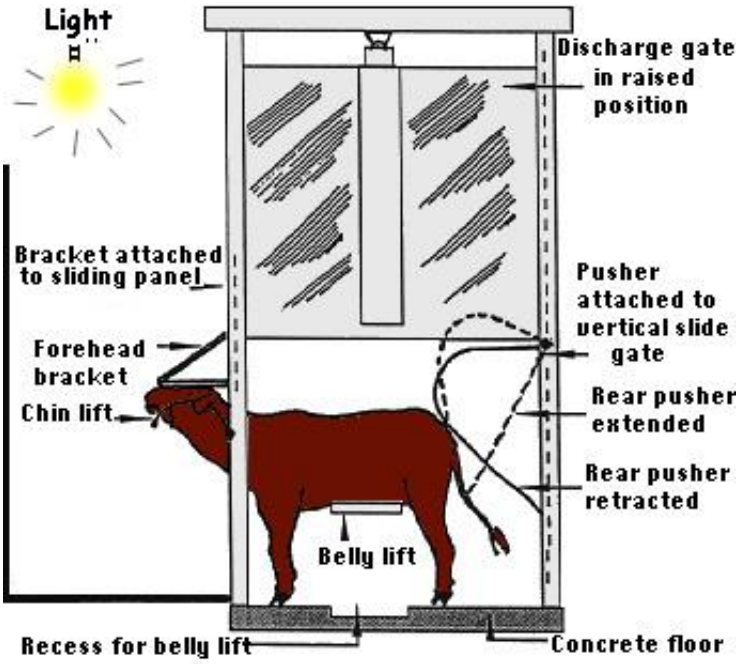
Head stanchions used for electrical stunning of cattle in New Zealand work quite well. The first author observed these systems in two plants. Most cattle entered the stunning box voluntarily and quietly placed their heads in the stanchion. The animal was immediately stunned after its head was clamped. Immediate

electrical stunning is essential in order to prevent the animal from fighting the stanchion. When this system was operated correctly the cattle were quiet and calm. The electric stun stanchion did not restrain the body. For ritual slaughter or captive bolt stunning devices to restrain the body are strongly recommended. Animals remain calmer in head restraint devices when the body is also restrained. Stunning or slaughter must occur within 10 seconds after the head is restrained.

Reactions to the throat cut

The variable of reactions to the incision must be separated from the variable of the time required for the animal to become completely insensible. Recordings of EEG or evoked potentials measure the time required for the animal to lose consciousness. They are not measures of pain. Careful observations of the animal's behavioural reactions to the cut are one of the best ways to determine if cutting the throat without prior stunning is painful. The time required for the animals to become unconscious will be discussed later.

Observations of over 3000 cattle and formula-fed veal calves were made by the first author in three different U.S. kosher slaughter plants. The plants had state of the art upright restraint systems. The systems are described in detail in Grandin (1988,1991,1992,1993a). The cattle were held in either a modified ASPCA pen:

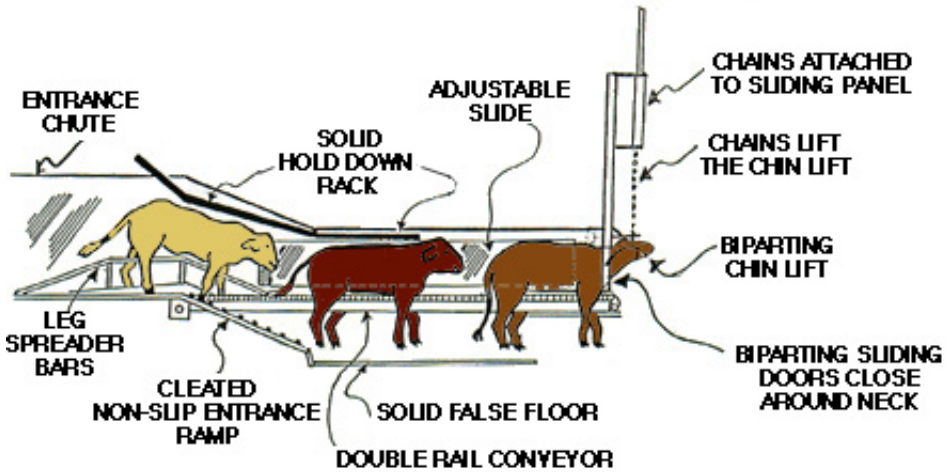


This drawing illustrates (on the left side, in front of the animal) the solid barrier that is necessary to block the animal's vision.
The sides of the ASPCA box must also be completely solid

or a double rail (centre track) conveyor restrainer:

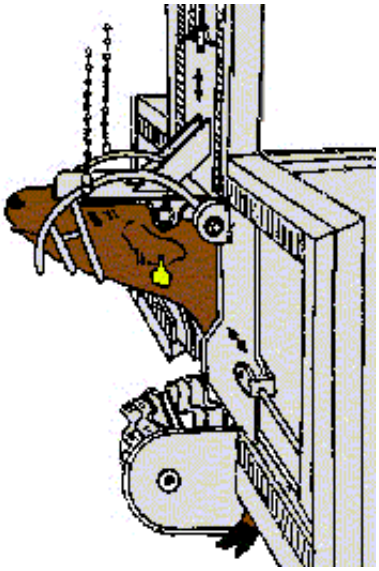
To induce the cattle to stay still and ride quietly, the solid hold down rack MUST be

long enough so that the animal entering the restrainer can NOT see out until it's feet are completely off the enterance ramp.



This equipment was operated by the first author or a person under her direct supervision. Very little pressure was applied to the animals by the rear pusher gate in the ASPCA pen. Head holders were equipped with pressure limiting devices. The animals were handled gently and calmly. It is impossible to observe reactions to the incision in an agitated or excited animal. Blood on the equipment did not appear to upset the cattle. They voluntarily entered the box when the rear gate was opened. Some cattle licked the blood.

In all three restraint systems, the animals had little or no reaction to the throat cut. There was a slight flinch when the blade first touched the throat. This flinch was much less vigorous than an animal's reaction to an eartag punch. There was no further reaction as the cut proceeded. Both carotids were severed in all animals. Some animals in the modified ASPCA pen were held so loosely by the head holder and rear pusher gate that they could have easily pulled away from the knife.



These animals made no attempt to pull away. In all three slaughter plants, there was almost no visible reaction of the animal's body or legs dunng the throat cut. Body and leg movements can be easily observed in the double rail restrainer because it lacks a pusher gate and very little pressure is applied to the body. Body reactions during the throat cut were much fewer than the body reactions and squirming that occurred during testing of various chin lifts and forehead hold-down brackets. Testing of a new chin

lift required deep, prolonged invasion of the animal's flight zone by a person. Penetration of the flight zone of an extensively raised animal by people will cause the animal to attempt to move away (Grandin, 1993a). The throat cut caused a much smaller reaction than penetration of the flight zone. It appears that the animal is not aware that its throat has been cut. Bager et al., (1992) reported a similar observation with calves. Further observations of 20 Holstein, Angus and Charolais bulls indicated that they did not react to the cut. The bulls were held in a comfortable head restraint with all body restraints released. They stood still during the cut and did not resist head restraint. After the cut the chin lift was lowered, the animal either immediately collapsed or it looked around like a normal alert animal. Within 5 to 60 seconds, the animals went into a hypoxic spasm and sensibility appeared to be lost. Calm animals had almost no spasms and excited cattle had very vigorous spasms. Calm cattle collapsed more quickly and appeared to have a more rapid onset of insensibility. Munk et al.,(1976) reported similar observations with respect to the onset of spasms. The spasms were similar to the hypoxic spasms which occur when cattle become unconscious in a V-shaped stanchion due to pressure on the lower neck. Observations in feedyards by the first author during handling for routine husbandry procedures indicated that pressure on the carotid arteries and surrounding areas of the neck can kill cattle within 30 seconds.

The details spelled out in Jewish law concerning the design of the knife and the cutting method appear to be important in preventing the animal from reacting to the cut. The knife must be razor sharp and free of nicks. It is shaped like a straight razor and it must be twice the width of the animal's neck. The cut must be made without hesitation or delay. It is also prohibited for the incision to close back over the knife during the cut. This is called "halagramah" (digging) (Epstein, 1948). The prohibition against digging appears to be important in reducing the animal's reaction to the cut. Ritual slaughtermen must be trained in knife sharpening. Shochets have been observed using a dull knife. They carefully obeyed the religious requirements of having a smooth, nick-free knife, but they had failed to keep it sharp. Observations of Halal cattle slaughter without stunning done by a Muslim slaughterman with a large, curved skinning knife resulted in multiple hacking cuts. Sometimes there was a vigorous reaction from the animal.

Further observations of kosher slaughter conducted in a poorly designed holder, i.e., one which allowed the incision to close back over the knife during the cut, resulted in vigorous reactions from the cattle during the cut. The animals kicked violently, twisted sideways, and shook the restraining device. Cattle which entered the poorly designed head holder in an already excited, agitated state had a more vigorous reaction to the throat cut than calm animals. These observations indicated that head holding devices must be designed so that the incision is held open during and immediately after the cut. Occasionally, a very wild, agitated animal went into a spasm which resembled an epileptic seizure immediately after the cut. This almost never occurred in calm cattle.

Time to loss of consciousness

Scientific researchers agree that sheep lose consciousness within 2 to l5 seconds after both carotid arteries are cut (Nangeroni and Kennett, 1963; Gregory and Wotton, 1984; Blackmore, 1984). However, studies with cattle and calves indicate that most animals lose consciousness rapidly, however, some animals may have a period of prolonged sensibility (Blackwore, 1984; Daly et al, 1988) that lasts for over a minute. Other studies with bovines also indicate that the time required for them to become unconscious is more variable than for sheep and goats (Munk et al., 1976; Gregory and Wotten, 1984). The differences between cattle and sheep can be explained by differences in the anatomy of their blood vessels.

Observations by the first author of both calf and cattle slaughter indicate that problems with prolonged consciousness can be corrected. When a shochet uses a rapid cutting stroke, 95% of the calves collapse almost immediately (Grandin 1987). When a slower, less decisive stroke was used, there was an increased incidence of prolonged sensibility. Approximately 30% of the calves cut with a slow knife stroke had a righting reflex and retained the ability to walk for up to 30 seconds.

Gregory (1988) provided a possible explanation for the delayed onset of unconsciousness. A slow knife stroke may be more likely to stretch the arteries and induce occlusion. Rapid loss of consciousness will occur more readily if the cut is made as close to the jaw bone as religious law will permit, and the head holder is loosened immediately after the cut. The chin lift should remain up. Excessive pressure applied to the chest by the rear pusher gate will slow bleed out. Gentle operation of the restrainer is essential. Observations indicate that calm cattle lose consciousness more rapidly and they are less likely to have contracted occluded blood vessels. Calm cattle will usually collapse within 10 to 15 seconds.

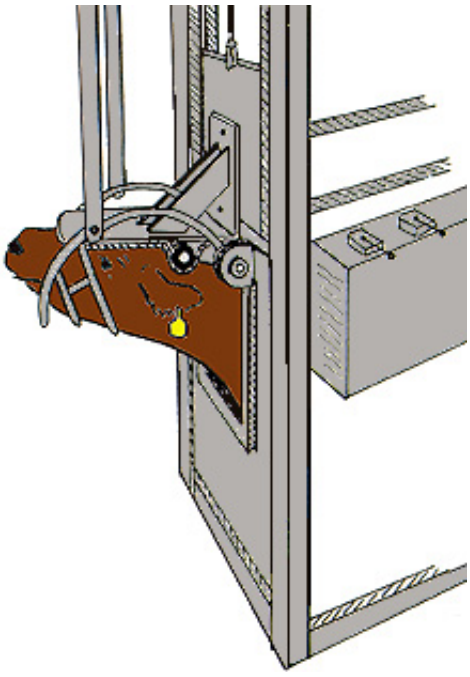
Upright restraint equipment design

Good upright restraint equipment is available for low stress, comfortable restraint of sheep, calves and cattle (Giger et al., 1977; Westervelt et al., 1976; Grandin, 1988,1991,1992,1993). To maintain a high standard of animal welfare, the equipment must be operated by a trained operator who is closely supervised by plant management. Handlers in the lairage and race areas must handle animals gently and induce each animal to calmly enter the restrainer. Unfortunately, some very poorly designed restraint systems have recently been installed in Europe. The designers had little regard for animal comfort. Below is a list of specific recommendations:

- All restraint devices should use the concept of optimal pressure.

  The device must hold the animal firmly enough to provide a "feeling of restraint" but excessive pressure that would cause discomfort should be avoided. Many people operating pens make the mistake of squeezing an animal harder if it struggles. Struggling is often a sign of excessive pressure.

- To prevent excessive bending of the neck, the bovine's forehead should be parallel to the floor. This positions the throat properly for ritual slaughter and stretches the neck skin minimizing discomfort. There is an optimal tightness for the neck skin. If it is too loose, cutting is more difficult. If it is too tight, the Jewish rule which prohibits tearing may be violated as the incision would have a tendency to tear before being cut by the knife. This also would be likely to cause pain. Some head restraints cause great distress to the cattle due to excessive bending of the neck in an attempt to obtain extreme throat skin tightness. This is not necessary for compliance with religious law. One must remember that 4000 years ago hydraulic devices which could achieve such extremes of throat tightness were not available. All head holders must be equipped with pressure limiting devices. Pressure limiting valves will automatically prevent a careless operator from applying excessive pressure. A 15 cm wide forehead bracket covered with rubber belting will distribute pressure uniformly and the animal will be less likely to resist head restraint. The forehead bracket should also be equipped with an 8 cm diameter pipe that fits behind the poll. This device makes it possible to hold the head securely with very little pressure.



- The rear pusher gate of the ASPCA pen must be equipped with a pressure limiting device. The animal must not be pushed too far forward in the head holder. The pressure must be regulated so that the animal stands on the floor with its back level. Arching of the back is a sign of excessive pressure. A calm relaxed animal will stand quietly in the pen and will not attempt to move its head. If the animal struggles, this is due to excessive pressure or being thrown off balance by the pusher gate.

- The animal must not be lifted off the floor by the belly lift of an ASPCA pen. The list is for restraint not lifting. Lift travel should be restricted to 71 cm from the floor to the top of the lift. Other restrainers such as the double rail system are designed to give full support under the belly. The conveyor slats must be shaped to fit the contours of the animal's sternum.

- All parts of the equipment should always move with a slow steady motion. Jerky motions or sudden bumping of the animal with the apparatus excites and agitates them. Jerky motion can be eliminated by installing flow control valves. These valves automatically provide a smooth steady motion even if the operator jerks the controls. All restraint devices should use the concept of **optimal (NOT maximum)** pressure. Sufficient pressure must be applied to give the animal a feeling of being held, but excessive pressure that causes struggling must be avoided. Animals will often stop struggling when excessive pressure is slowly reduced.

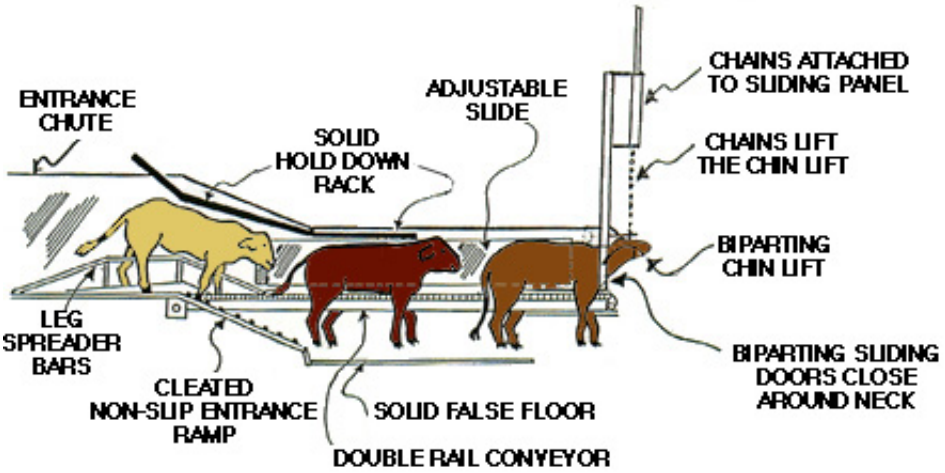
- All equipment must be engineered to reduce noise. Air hissing and clanging metal noises cause visible agitation in cattle. Air exhausts must be muffled or piped outside. Plastic guides in the sliding doortracks will further reduce noise.

- A solid barrier should be installed around the animal's head to prevent it from seeing people and other distractions in it's flight zone. This is especially important for extensively reared cattle, particularly when they are not completely tame. On conveyor systems the barrier is often not required because the animals feel more secure because they are touching each other.

- Restraint equipment must be illuminated to encourage animals to enter. Lighting mistakes or air blowing back at the animals will cause cattle to balk (Grandin 1993b). Distractions that cause balking must be eliminated.

For plants which slaughter small numbers of sheep and goats a simple upright restrainer can be constructed from pipe (Giger et al., 1977). For veal calf plants a small ASPCA pen can be used. For large high speed plants a double rail restrainer can be equipped with a head holding device.

To induce the cattle to stay still and ride quietly, the solid hold down rack MUST be long enough so that the animal entering the restrainer can NOT see out until it's feet are completely off the enterance ramp.



Some rabbinical authorities prefer inverted restraint and cutting downward because they are concerned that an upward cut may violate the Jewish rule which forbids excessive pressure on the knife. There is concern that the animal may tend to push downward on the knife during an upward cut. Observations indicate that just the opposite happens. When large 800 to 950 kg bulls are held in a pneumatically powered head restraint which they can easily move, the animals pull their heads upwards away from the knife during a miscut. This would reduce pressure on the blade. When the cut is done correctly, the bulls stood still and did not move the head restraint. Equal amounts of pressure were applied by the forehead bracket and the chin lift.

Upright restraint may provide the additional advantage of improved bleed out because the animal remains calmer and more relaxed. Observations indicate that a relaxed, calm animal has improved bleedout and a rapid onset of unconsciousness. Excited animals are more likely to have a slower bleedout. The use of a comfortable upright restraint device would be advantageous from a religious standpoint because rapid bleedout and maximum loss of blood obeys the biblical principle of:

> "Only be sure that thou eat not the blood: for the blood is life"
> (Deuteronomy 12:23)

Rapid bleedout and a reduction in convulsions provide the added advantage of reducing petechial haemorrhages and improving safety. Convulsing animals are more likely to injure plant employees. A calm, quiet animal held in a comfortable restraint device will meet a higher animal welfare standard and will have a lower incidence of petechial haemorrhages.

Welfare aspects of slaughter

Many welfare concerns are centered on restraint. In Europe and the U.S. highly stressful restraint devices are still being used. Many of these systems apply excessive pressure or hold the animal in a position that causes distress. The recent l992 decision by the Swedish Board of Agriculture to uphold its ban on slaughter without stunning was largely driven by their concerns about forceful immobilisation and clamping of cattle (Andersson et al., 1992). Proper design and operation of restraint devices can alleviate most of these concerns with cattle and sheep.

Restraint devices will perform poorly from an animal welfare standpoint if the animals balk and refuse to enter due to distractions such as shadows, air hissing or poor illumination. These easily correctable problems will ruin the performance of the best restraint system. Abusive workers will cause suffering in a well designed system. For more information about properly operating pens, see Grandin, 1993.

Restraint devices are used for holding animals both for ritual slaughter and for conventional slaughter where animals are stunned. The use of a head restraint will improve the accuracy of captive bolt stunning. In large beef slaughter plants without head restraint captive bolt stunning has a failure rate of 3 to 5, i.e., a second shot is required.

Captive bolt and electric stunning will induce instantaneous insensibility when they are properly applied. However, improper application can result in significant stress. All stunning methods trigger a massive secretion of epinephrine (Van der Wal 1978; Warrington 1974). This outpouring of epinephrine is greater than the secretion which would be triggered by an environmental stressor or a restraint method. Since the animal is expected to be unconscious, it does not feel the stress. One can definitely conclude that improperly applied stunning methods would be much more stressful than kosher slaughter with the long straight razor sharp knife. Kilgour (1978), one of the pioneers in animal welfare research, came to a similar conclusion on stunning and slaughter .

Halal (Muslim) slaughter performed with a knife that is too short causes definite distress and struggling in cattle. We recommend to those Muslim religious authorities who require slaughter without stunning that they require that the knife must be razor sharp with a straight blade that is at least twice the width of the neck. Unless the animals are stunned, the use of curved skinning knives is not acceptable. Due to the fact that Muslim slaughtermen do not usually receive as extensive special training in slaughter techniques as Jewish Shochtim, preslaughter stunning is strongly recommended. As stated earlier, reversible head-only electrical stunning is accepted by most Muslim religious authorities. Preslaughter stunning allows plants to run at higher line speeds and maintain high standards of animal welfare.

In some ritual slaughter plants animal welfare is compromised when animals are pulled out of the restraint box before they have lost sensibility. Observations clearly indicated that disturbance of the incision or allowing the cut edges to touch caused the animal to react strongly. Dragging the cut incision of a sensible animal against the bottom of the head opening device is likely to cause pain. Animals must remain in the restraint device with the head holder and body restraint loosened until they collapse. The belly lift should remain up during bleedout to prevent bumping of the incision against the head opening when the animal collapses.

Since animals cannot communicate, it is impossible to completely rule out the possibility that a correctly made incision may cause some unpleasant sensation. However, one can definitely conclude that poor cutting methods and stressful restraint methods are not acceptable. Poor cutting technique often causes vigorous struggling. When the cut is done correctly, behavioural reactions to the cut are much less than reactions to air hissing, metal clanging noises, inversion or excessive pressure applied to the body. Discomfort during a properly done shechitah cut is probably minimal because cattle will stand still and do not resist a comfortable head restraint device. Observations in many plants indicate that slaughter without stunning requires greater management attention to the details of the procedures than stunning in order to

maintain good welfare. Ritual slaughter is a procedure which can be greatly improved by the use of a total quality management (TQM) approach to continual incremental improvements in the process. In plants with existing upright restraint equipment significant improvements in animal welfare and reductions in petechial haemorrhages can be made by making the following changes:

- training of employees in gentle calm cattle handling
- modifying the restrainer per the specifications in this article
- eliminating distractions which make animals balk
- and careful attention to the exact cutting method

There needs to be continual monitoring and improvements in technique to achieve rapid onset of insensibility. A high incidence of prolonged sensibility is caused by poor cutting technique, rough handling, excessive pressure applied by the restraint device, or agitated excited animals.

The meat industry and other animal industries need to constantly strive to improve their methods and to use the best available technology. The industry must be the leader in bringing about legitimate animal welfare goals. The veterinarian, the animal scientist, and the meat scientist can often be an important and positive contributor to this process. With your knowledge of animal biology and behaviour, you should be speaking up in a positive way for the best possible processes to slaughter animals while respecting the religious needs of others. The responsibility of all those involved in animal agriculture is to assure that animals are properly handled at all times.

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