

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

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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, sex, 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 part 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 injuries 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 older 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).

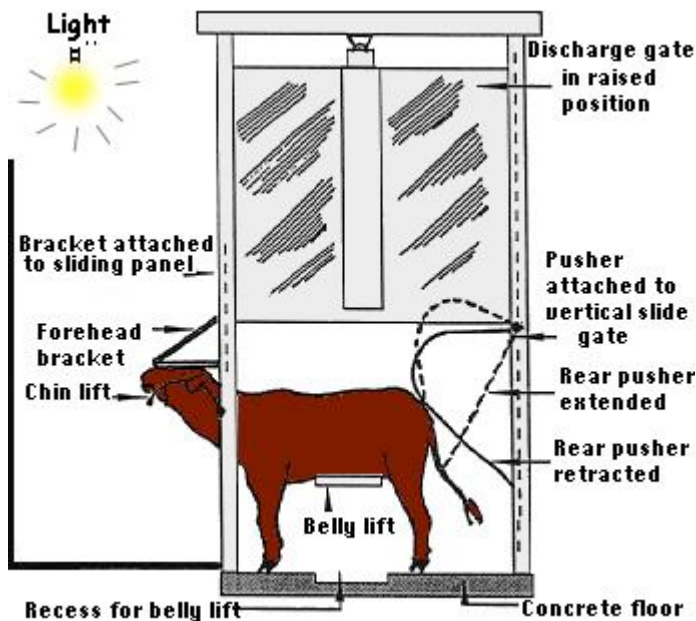
Head stanchions used for electrical stunning of cattle in New Zealand work quite well. The first author observed these systems in two plants. Most cattle entered the stunning box voluntarily and

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:

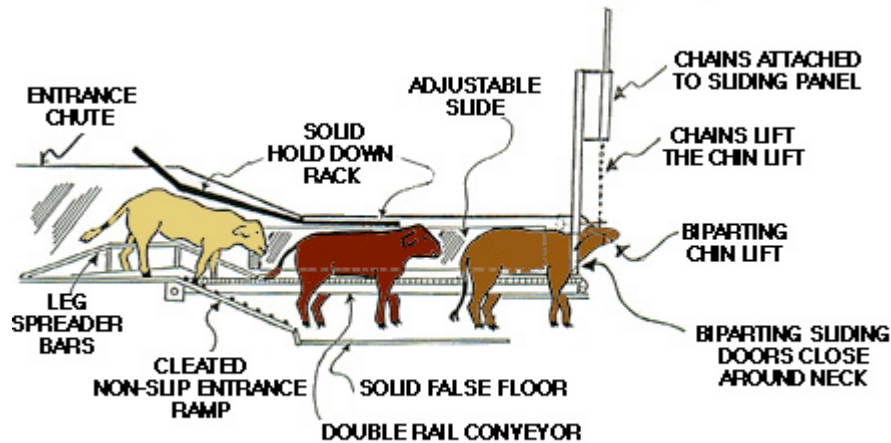


This drawing illustrates (on the left side, in front of the animal) the solid barrier that is necessary to block the animal's vision.

The sides of the ASPCA box must also be completely solid

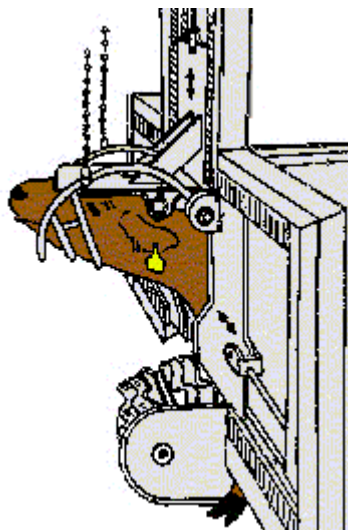
or a double rail (centre track) conveyor restrainer:

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 entrance 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 during 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 15 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 (Blackmore, 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 Wotton, 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.

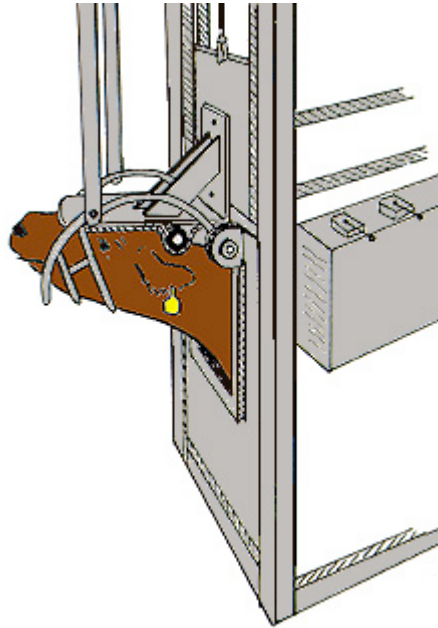
Upright restraint equipment design

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.

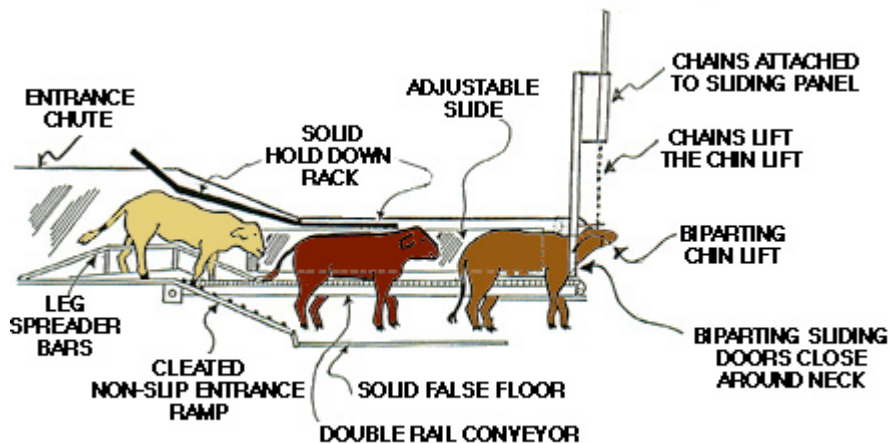


- The rear pusher gate of the ASPCA pen must be equipped with a pressure limiting device. The animal must not be pushed too far forward in the head holder. The pressure must be regulated so that the animal stands on the floor with its back level. Arching of the back is a sign of excessive pressure. A 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 lift 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 its 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 entrance 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 1992 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.

References :

- Andersson, B.; Forslid, A.; Olsson, K; Ronnegard, J.O. (1992)

Slaughter of Unstunned Animals.

Swedish Board of Agriculture Report 37

- Bager, F.; Braggins, T.J.; Devine, C.E.; Graafhus, A.E.; Mellor, D.J.; Taener, A.; Upsdell, M.P. (1992)

Onset of insensibility in calves: Effects of electroplectic seizure and exsanguination on the spontaneous electrocortical activity and indices of cerebral metabolism.

Resource Veterinary Science 52 pages 162-173

- Blackmore, D.K (1984)

Differences in the behaviour of sheep and calves during slaughter.

Resource Veterinary Science 37 pages 223-226

- Daly, C.C.; Kallweit, E.; Ellendorf, F. (1988)

**Cortical function in cattle during slaughter:
Conventional captive bolt stunning followed by exsanguination compared to shechita slaughter.**

Veterinary Record 122 pages 325-329

- Dunn, C.S. (1990)

Stress reactions of cattle undergoing ritual slaughter using two methods of

restraint.

Veterinary Record 126 pages 522-525.

- Epstein, I. (Editor) (1948)

The Babylonian Talmud.

Soano Press, London

- Giger, W.; Prince, RP.; Westervelt, R.G.; Kinsman, D.M. (1977)

Equipment for low stress animal slaughter.

Trans. American Society Agricultural Engineers 20 pages 571-578

- Grandin, T. (1987)

High speed double rail restrainer for stunning or ritual slaughter.

International Congress of Meat Scientists and Technology; pages 102-104

- Grandin, T. (1988)

Double rail restrainer for livestock handling.

Journal Agricultural Engineers Resource 41 pages 327-338

- Grandin, T. (1991)

Double rail restrainer for handling beef cattle.

Technical Paper 915004, American Society Agricultural Engineers
St. Joseph, Michigan

- Grandin, T. (1992)

Observations of cattle restraint devices for stunning and slaughtering.

Animal Welfare 1 pages 85-91

- Grandin, T. (1993)

**Management commitment to incremental improvements greatly improves
livestock handling.**

Meat Focus October pages 450-453

- Gregory, N. (1988)

**Published Discussion, 34th International Congress of Meat Science and
Technology, Workshop on Stunning of Livestock**

CSMO Meat Research Laboratory, Brisbane, Australia, page 27

- Gregory, G.; Wotton, S.D. (1984)

Time of loss of brain responsiveness following exsanguination in calves.

Resource Veterinary Science 37 pages 141-143

- Grunfeld (1972)

The Jewish Dietary Laws.

Sonano Press, London

- Kilgour, R. (1978)

Journal of Animal Science 46 page 1478

- Nangeroni, L.L.; Kennett, P.D. (1963)

An Electroencephalographic Study of the Effect of Shechita Slaughter on Cortical Function of Ruminants.

Unpublished report, Department of Physiology, New York State Veterinary College, Cornell University, Ithaca, New York

- Mitchell, G.; Hahingh, J.; Ganhao, M. (1988)

Stress in cattle assessed after handling, transport and slaughter.

Veterinary Record 123 pages 201-205

- Munk, M.L.; Munk, E.; Levinger, I.M. (1976)

Shechita: Religious and Historical Research on the Jewish Method of Slaughter and Medical Aspects of Shechita.

Feldheim Distributors, Jerusalem

- Tume, R.K; Shaw, F.D. (1992)

Beta endorphin and cortisol concentration in plasma of blood samples collected during exsanguination of cattle.

Meat Science 31 pages 211-217

- van der Wal, P.G. (1978)

Chemical and physiological aspects of pig stunning in relation to meat quality.

A review. Meat Science 2 pages 19-30

- Warrington, R. (1974)


Electrical stunning: A review of the literature.

Veterinary Bulliton 44 pages 617-633

- Zavy, M.T.; Juniewicz, P.E.; Phillips, W.A.; Von Tungeln, D.L. (1992)

Effect of initial restraint, weaning and transport stress on baseline ACTH stimulated cortisol response in beef calves of different genotypes.

American Journal of Veterinary Resource 53 pages 551-557

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