Review article

The analgesic properties of cryotherapy using hyperbaric CO_2

Cryotherapy is an analgesic and antalgesic technique that uses the effects of thermal shock. Easy to implement, its applications are varied, but however, remain to be validated.

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Treating pain is an everyday activity for the practitioner. There remains much to be done in this field however. The evaluation of pain remains subjective [4]. There are parameters that can be observed in studying pain [4, 5, 6]: the general condition of the horse, its behaviour, its heart rate, its reaction to the palpation of painful areas, the level of beta-endorphins, catecholamines and corticosteroids [9], the response to a given pressure, measuring on a force platform, analysis of its walk, thermography, its response to antalgesics. Proposals for a pain evaluation scale in horses have been put forward [6], but to this day, none is really satisfactory. The antalgesic treatment most commonly used is with non-steroidal anti-inflammatory drugs. Analgesic treatment is with the opiates, alpha-2 agonists, local anaesthetics, anti-irritants [16] and acupuncture [12]. Cryotherapy occupies a place all of its own in all this: an antalgesic and analgesic technique, it is used a lot and in different ways. In man, cryotherapy is used in the post-operative treatment of osteoarticular surgery [8], in sports medicine and in physiotherapy. In horses, the analgesic properties of cold and heat are used traditionally (see the tables “The effects of heat and cold” and “Traditional therapeutic uses of heat and cold”). However, publications on cryotherapy are rare [3, 10, 14]. In this article, the cryotherapy technique using hyperbaric $C0_2$ is described and the applications for horses considered. The equipment used is a Cryofast™ device which produces carbon dioxide at -78°C, using the technique invented by C. Cluzeau(1).

Points to note

- Cryotherapy is a technique that uses intense, powerful cold for a short period. It is different from adjuvant techniques like ice and techniques that are destructive of cells like cryosurgery using liquid nitrogen.
- CO_2 under pressure provides sufficient cold (-78 °C) that is powerful (pressure), painless (dry), for a short period (30 seconds to several minutes). In horses, these conditions enable thermal shock to be easily obtained.
- Thermal shock is the result of local and general reactions in the organism under the effect of the cold.
- The effects of thermal shock are anaesthetic, analgesic, antalgesic, anti-inflammatory, vasomotor, muscle relaxant, and anti-oedematous.
- The indications and treatment protocols are numerous.
- Trigger points are a major but often neglected cause of pain and functional troubles of the skeletal musculature.

Key words

Cryotherapy, thermal shock, pain, analgesic, trigger points, horse, Equidae.

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Effects of cryotherapy: thermal shock

Cryotherapy is different from cryosurgery. The aim of cryosurgery, which is better known, is the selective and non-inflammatory destruction of tissue. It is used in the surgical treatment of tumours. The aim of cryotherapy is not the destruction of tissue it has a local metabolic action and induces a general reaction in the organism, known as thermal shock.

Effects of heat	**Effects of cold**
▪ Pain ↓ (drains mediators of inflammation)	▪ Pain ↓ (nervous conduction slowed)
▪ Flexibility, elasticity of muscles ↑	▪ Flexibility, elasticity of muscles ↓
▪ Stiffness ↓	▪ Stiffness ↑, but as the pain reduces mobility may be regained later
▪ Oedema ↑ (but drainage as well)	▪ Oedema ↓
▪ Diameter of capillaries ↑	▪ Diameter of capillaries ↓ then ↑ (rebound)
▪ Nervous conductivity ↑	▪ Nervous conductivity ↓

The effects of heat and cold: traditional concept. (After F. Desbrosse).

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Thermal shock corresponds to the response of the organism in the face of intense and powerful cold. The cold is transmitted to the organism via the skin, involving the epidermis (ectoblast), the mesoderm (mesoblast) and the hypoderm (endoblast) (see figure "Transmission of cold in an organism"). When the temperature of the skin drops suddenly to 4^0C, the cutaneous and subcutaneous receptors are activated. The pain receptors are the first to be affected, then the temperature sensitive Ruffini's corpuscles, then the pressure sensitive Pacini's corpuscles, and finally the laminated mechanoreceptors. Information is transmitted in the diencephalons (neurons of the pre-optic region of the hypothalamus), triggering a neuro-vegetative response involving the ortho and para-sympathetic systems. The mechanisms are, therefore, similar to those of water shock. As the time required is short, the affect on tissue is kept to a minimum, only non-myelinized, and therefore unprotected, type C pain receptor fibres, may be affected. At the vascular level, the cold initially acts as a vasoconstrictor. Physiological control returns rapidly and is expressed by vasodilation, blocking of nociception, and re-establishment of kinaesthesia and proprioception.

The effects of cryotherapy are the following: an anaesthetic action, an anti-inflammatory reaction, a vasomotor action, action on the semi-permeable membranes and a muscle-relaxant effect.

- The analgesic action occurs very rapidly. It is due to a reduction in the sensitivity of the pain receptors, a slowing of nervous conductivity and the "*gate-control*" effect. It is subsequently maintained thanks to the physiological control mechanism referred to above.
- The anti-inflammatory action is due, on the one hand to the destruction of certain thermolabile enzymes (hyaluronidase, elastase and collagenase, etc), and on the other, to the slowing down of the production of enzymes which are not sensitive to heat, but which depend on the slowing down of metabolism in the tissues (histamine, bradykinin, serotonin, prostaglandin, etc).
- The vasomotor action (peripheral vasoconstriction) is powerful (estimated at forty percent) and is produced rapidly (in about ten seconds) when skin temperature falls to 4^0 C. A cascade of vasomotor reflexes then follows. They commence very soon after thermal shock, lasting from fifteen to thirty minutes, with vasodilation occurring first, (protective congestion), then alternating vasoconstriction and vasodilation (*hunting response*).
- The mechanism responsible for the muscle relaxant effect is not well-understood. The reduction in muscular spasm seems to be due to the inhibiting of γ-motor activity (inverse myotatic reflex) and a reduction in the conduction speed of nervous influx. A reduction in metabolism also occurs.
- The action of the semi-permeable membranes gives cryotherapy an anti-edematous effect.

Therapeutic uses of heat	Therapeutic uses of cold
Chronic phenomena	Acute phenomena
Lack of joint movement due to fibrosis	Lack of joint movement due to pain
Draining oedema	Blocking oedema
Osteoarthritis	Arthritis
Chronic tendonitis	Acute tendonitis

Traditional therapeutic uses of heat and cold. The choice of treatment by heat or by cold does not only depend on the type of disease, but also on the physiological condition of the part concerned.
After F. Desbrosse.

Characteristics of therapeutic cold

The cold is characterized by its intensity, its power, length of application and ambient humidity.

A very low temperature (-60^0 C and below) is required to obtain thermal shock in a short time. Techniques using cold above -60^0 C are considered as being adjuvant treatments.

When a cold gas phase is used, it is the rate of flow that gives the power. Polar explorers know this phenomenon well: there is a scale of biological effects of cold depending on wind speed. Thus, with an outside temperature of -40^0 C, if there is a 30 km/hour blizzard, the biological effects are the equivalent of an outside temperature of -65^0 C without a wind (see table “Equivalent temperature depending on wind speed”).

The application time of cold determines the onset of thermal shock. Lecroart studied the vasomotor reflex induced by cold, comparing the effect of ice and that of low temperatures (-60^0 C and below) (see the figure “Comparison curve of ice-very low temperatures”). A vasoconstriction peak of 38% is obtained in thirty seconds with ice, and in seven seconds with very low temperatures; a vasodilation peak of 80% appears in twenty minutes with ice, and of 117% in twenty seconds with very low temperatures. In addition, the increase in the time of application of cold is accompanied by tissue destruction.

Humidity must be taken into account because applying wet cold is painful. Frost is tolerated better than ice.

Wind Speed in Kph												
70	- 7	- 14	- 20	- 27	- 33	- 40	- 46	- 52	- 59	- 65	- 72	- 78
60	- 7	- 13	- 19	- 26	- 32	- 39	- 45	- 51	- 58	- 64	- 70	- 77
50	- 6	- 12	- 18	- 25	- 31	- 37	- 43	- 49	- 56	- 62	- 68	- 74
40	- 5	- 11	- 17	- 23	- 29	- 35	- 41	- 47	- 53	- 59	- 65	- 71
30	- 3	- 8	- 14	- 20	- 25	- 31	- 37	- 43	- 48	- 54	- 60	- 65
20	0	- 5	- 10	- 15	- 21	- 26	- 31	- 36	- 42	- 47	- 52	- 57
10	5	0	- 4	- 8	- 13	- 17	- 22	- 26	- 31	- 35	- 40	- 44
	8	4	0	- 4	-8	- 12	- 16	- 20	- 24	- 28	- 32	- 36

Air temperature (^{0}C)

The production of therapeutic cold

According to the level of cold they provide, above or below -60^0 C, devices or techniques are considered as being adjuvant, or completely separate treatments. Hydrotherapy, the use of ice packs, sprays, coldpacks and refrigerated air compressors come into the category of adjuvants, therefore, while the use of compressed carbon dioxide (-78 ^{0}C) and liquid nitrogen (-196^0 C) come into the category of treatments (see the figure “The scale of cooling”).

The effectiveness of hydrotherapy depends on the temperature and the rate of flow of the water used. A mountain torrent where the water is at 10 ^{0}C and flowing strongly, is effective for the treatment of the extremities, but its effect is painful and it is difficult to remain in it for very long! A river where the water is at 15^{0}C and flowing gently is not very effective. Crushed ice is widely used, but prolonged application is necessary to obtain any effect: ten minutes are necessary to reduce skin temperature to 15^{0}C and thirty minutes to reduce it to 12^{0}C [14]. In addition, the cold produced is wet and in treatments lasting more than twenty minutes, tissue damage may result. Cold sprays produce cold of -40^{0}C, but the rate of flow is feeble and therefore lacks power.

Liquid nitrogen provides a very low temperature of -196^{0}C. It is accompanied by tissue destruction and is therefore used for cryosurgery. Anhydrous CO_2, compressed to 50 bar provides cold at -78^{0}C, it is painless, and provides sufficient power to provoke thermal shock, lowering skin temperature to 4^{0}C, over a time period that runs from 30 seconds to several minutes, depending on the state of the hair and the severity of the surrounding inflammation. It is this last technique, developed by C. Cluzeau[(1)], that we use.

Indications and contraindications of cryotherapy in horses

Cryotherapy is a recent technique. It is therefore more appropriate to speak of current and prospective applications rather than indications. Applications flow directly from the effects of thermal shock.

Among these effects, analgesic, reflex, muscle relaxant, anti-inflammatory and anti-edematous actions are of interest. Cryotherapy is thus used for the treatment of dorsalgia, in osteopathy and physiotherapy, for the treatment of osteoperiostitis and epiphysitis, in tendonitis and dermatitis, in osteoarticular and tendinous post operative surgery, in traumatology and in haematomas. Treatment protocols for these different applications vary.

In horses there a no known contraindications. In man, contraindications are allergy to cold, Raynaud’s syndrome, and disorders relating to sensitive skin, cryoglobulinemia, diabetes and metabolic illnesses. There is a local risk of freezing the skin when cold is applied to a particular point for too long, or too close.

Particular cases of trigger-points

A trigger-point may be defined [1, 15] as an area of hyper-sensitivity in a tissue, which, when pressure is applied, is locally sensitive. In a situation of hypersensitivity, this area gives rise to pain, referred sensitivity, and sometimes neuro-vegetative phenomena and proprioceptive disorders. Depending on their localization, these trigger-points are described as myofascial, cutaneous, fascial, ligamentary and periosteum.

A trigger-point’s referred pain [12], is a pain originating from the trigger-point but which is felt in an area some distance away. It is, in the sense that it can be reproduced, specific to its point of origin, but does not necessarily correspond to the full area of innervation of a peripheral nerve or a dermatome.

For man there is a detailed map of trigger-points and their corresponding areas of referred pain [15]. Such as map also exists for horses [7] but remains to be validated.

The trigger-point may be active and responsible for the pain and the functional difficulties observed. It may also be latent, clinically silent from the point of view of pain, but may then be the cause of a limitation of mobility and weakness in the muscle affected. The latent point may persist for a number

of years, and remain predisposed to pass to the active state under a favourable stimulus, however minor.

Pain is increased by moderate palpation of these active trigger-points. In man this pain is felt as being dull, persistent and deep. It should therefore be distinguished from exquisite pain. From stimuli applied directly to a muscle, such as sudden effort, overexertion, tiredness, cold, traumatism or biomechanical phenomena, and *via* the central and medullar response, a trigger-point is activated and causes an extension of the pain (see figure “Pain mechanism linked to the activation of myofascial trigger points”).

Painful stimuli also come from the reference area of the trigger-point. The cortex does not interpret data well from the two areas of pain receptors. Cryotherapy allied to the trigger-point (see figure “Diagram representing the nerve pathways that may explain the effectiveness of cryotherapy applied to the skin over an active myofascial trigger-point”) “scrambles” the commands from the medulla, reducing the sensitivity of the motor neurons that innervate the muscle, by the “*gate-control*” system. There is then descending inhibition and a fall in the contraction reflex; there is also rising inhibition and a reduction in pain. The more the cold is active, the more the stimulus is felt as abnormal by the cortex which goes onto “general alert”, inhibiting reflex phenomena. The feedback mechanisms maintaining the trigger-point centrally are interrupted [2]. Extension of the muscle is then possible for there is no longer any reflex arc to maintain the spasm. This muscular extension allows kinaesthesia and proprioception to be re-established.

Other treatments exist apart from cryotherapy: injecting the trigger-point with an anaesthetic/anti-inflammatory mixture, local injection of drugs, ischemic compression, massage, stretching, ultrasound, heat, shock waves, and TENS (*transcutaneous electrical nerve stimulation*). These techniques may be used alone or in combination.

Detecting trigger-points is carried out by palpation (photos **1** to **4**); finger pressure applied over the trigger point increases referred pain. Locally, the trigger-point is characterized by increased sensitivity. The fascial point corresponds to a depression that arrests the finger and a discrete oedema are sometimes discernable. The myofascial point maintains a localized muscle spasm that changes the consistency of the muscle at this point. The presence of areas of tension and induration in the muscle is what is being sought. These areas present themselves as bands of tension or nodules which feel like pebbles. Areas of tension and induration are about a centimetre in size, while a trigger point is in the order of a millimetre or so.
The palpation technique depends on the region being examined. At the level of the back, palpation is carried out flat. The muscles that are thus accessible are gripped between the thumb and the fingers, then “worked” by pinching with the fingers and pressure from the palm of the hand. This manual manipulation is carried out in stages, the muscle first being isolated by gentle massage (it’s the palm of the hand that should be used), then it is pinched with the fingers and worked. A normal muscle is relaxed by this manipulation. When there is a trigger-point, the muscle relaxes during the massage phase, then contracts painfully when pinched. It is during the course of these cycles of contracting/relaxing that it is possible to identify possible areas of tension and induration.
For other muscles, such as the arm and head muscles, the semitendinous muscles, and the semimembraneous muscles, it is possible to carry out palpation by pinching the muscle, which is then rolled with the fingers.

The locating and treatment of trigger-points is not sufficient: reoccurrence of the problem should be prevented. This depends on the factors activating or maintaining the trigger-point. These factors are varied, and may be bio-mechanical, metabolic, or linked to various diseases. Even if he is a specialist, the practitioner needs to call on his general clinical intuition to discern these factors.

Treatment protocol for using cryotherapy

As things stand at present, we use in practice, five different protocols (see table “Treatment protocols for cryotherapy in horses”). With the hyperbaric CO_2 technique, a short session lasts for thirty seconds, a medium session, a minute, and a long session, several minutes.
- Pain caused by trigger-points responds, most often, to a single, short session of cryotherapy.
- Conversely, where inflammation is involved, longer sessions are required and have to be repeated over several days.

▪ The prevention of post-operative painful episodes and inflammation is carried out by means of three to five sessions, short, and at three hourly intervals.
▪ The treatment of tendonitis requires the cryotherapy equipment to be available at the trainer's. Two sessions daily are linked to exercise. The first session is very short, localized on the site of exquisite pain [5] and is carried out from thirty minutes to two hours before exercise. The effects sought here are antalgesic and muscle relaxant. The object is to avoid through effort, tetany of the flexor muscles that reduces the functional elasticity of the muscle-tendon apparatus, increases tendon stress and sets up a cycle of auto-aggravation.
The second session is carried out after exercise, when the skin and hair are dry. It lasts longer, and involves the whole tendon. Here it is the anti-inflammatory and vascular effects that are taken advantage of.
▪ The final protocol concerns haematomas. Three to five average length treatments are carried out at forty-five minute intervals.

Method of application

Setting up a cryotherapy session requires certain rules to be followed in order to ensure its effectiveness and that it does not cause any harm. The area to be treated should be defined and prepared, the horse should be prepared, thermal shock created, and then maintained. Once the treatment is finished, the degree of analgesic effect obtained should be ascertained, and the region treated should be mobilized or stretched.

Protocol	**1**	**2**	**3**
Type of disorder concerned	Trigger points (fascia, muscle, bone)	Inflammation	Postoperative Tendons, ligaments
Practical applications	▪ Back pain ▪ Splints, epiphysitis ▪ Contractures	▪ Arthritis, periarthritis ▪ Paratenonitis, bursitis	▪ Osteoarticular (stifle joint) ▪ Tendons (fetlock) ▪ Fetlock suspensory ligament
Anticipated action of thermal shock	▪ Reflex therapy ▪ Muscle relaxant	▪ Anti-inflammatory ▪ Aoedematoustous	▪ Antalgesic ▪ Prevention of inflammation
Preparation of the site	▪ Grooming ▪ Dry skin and hair	▪ Clipping desirable ▪ Dry skin and hair	▪ Removable dressing the first day
Surface to be treated by sweeping	▪ The point, then extension to the muscle or pain	▪ Deformation, mainly	▪ The site of the operation and the surrounding areas
Length of cold - to achieve - to maintain thermal shock	 ▪ 30 secs. to 1 min ▪ 30 secs. to 1 min	 ▪ one to several minutes ▪ one minute	 ▪ 30 seconds to 1 min ▪ 30 seconds
Immediate aftercare	▪ Stretching (passive mobilization, induced posture, gentle gallop)	▪ Passive joint mobilization	▪ Replace dressing each time
Number and pattern of sessions	Normally one session is sufficient	▪ Repeated sessions: 1 to 3 times/d D_0, then 1 time/d from D_1 to D_3 or D_5	▪ Sessions repeated every 3 hours on D_0 then stop
Results and tests for effectiveness	▪ at T_0 pain disappears and muscles relax ▪ at T_{10} min, locomotion and negation of the surcingle test, for ex.	▪ at T_0 reduction in local pain, improved passive mobilization ▪ at T_3 h resorption of deformation, drop in skin temperature of from 1 to 3 degrees	▪ at T_3 h more comfortable (stifle joint) ▪ at D_3 oedema absent

Treatment protocols for cryotherapy in horses, from 235 cases. From F. Desbrosse.

Delimitation of the area to be treated

The area to be treated is determined by local signs.
- Signs may be algetic, for example for trigger-points (photos **1**, **2**, **3** and **4**). Treatment is carried out in concentric fashion over a few centimetres, over and around the point detected, then it should be extended in the direction of the referred pain. If it is a question of a muscle, treatment is extended over the muscle on each side of the muscular trigger-point that has been detected (photo **5**).
- Local signs may be deformations: in the case of splints, haematomas, contusions, epiphysitis, etc, the application area being limited to the deformation. However, if the area to be treated is small, it is advisable to extend the treatment in the direction of the referred pain. Indeed, studies carried out in man show that where cold is only applied to a small area, reactions are only local, and that a much greater area is required to provoke both local and general reactions [11].
- When the local signs are inflammation, application should be centred on the point of greatest inflammation, and extended eccentrically around this point.

Preparation of the area of treatment

Once defined, the area to be treated is prepared. The skin should be completely dry, otherwise treatment is painful. The presence of wounds or operation scars is not an obstacle since carbon dioxide is bacteriostatic. The presence of hair is not a major inconvenience to cryotherapy, but nevertheless does represent a hindrance: the quantity of gas required to obtain thermal shock is doubled when the hair is not clipped.

Preparation of the horse

Preparation of the horse is minimal and treatment can take place just as well in the box as in a specialized area. Generally speaking, it is not necessary to sedate the horse, but physical restraint is sometimes useful. Noise may frighten some horses: in this case, its ears should be blocked with cotton-wool. The behaviour of the horse may not just influence the carrying out of the treatment, but in addition has an effect on the effects of thermal shock. If the horse is tense, it is more difficult to lift the pain and obtain relaxation of the muscles. In this context, a degree of sedation is therefore desirable, but deep neuroleptanalgesia can also inhibit the control mechanisms induced by thermal shock.

Creating and maintaining thermal shock

The objective is, therefore, to bring about thermal shock by the application of cold to the predetermined and prepared area. If this area is subject to inflammation, it is wise to measure it and its temperature first, so that the case can be followed up objectively. In the same way, parameters for evaluating the level of pain should also be determined.

Treatment protocols for cryotherapy in horses

Protocol	**4a**	**4b**	**5**
Type of disorder concerned	Tendons, ligaments **before exercise**	Tendons, ligaments **after exercise**	Haematomas
Practical applications	▪ Pain without indications from diagnostic ultrasound	▪ Rehabilitation	▪ All types of haematoma
Anticipated action of thermal shock	▪ Reflex therapy ▪ Prevention of tetany ▪ Facilitation of proprioception	▪ Reflex therapy ▪ Anti-inflammatory	▪ Reflex therapy ▪ Anti-inflammatory
Preparation of the site	▪ Dry skin and hair	▪ Dry skin and hair	▪
Surface to be treated by sweeping	▪ The sensitive point	▪ The whole tendon	▪ The whole haematoma
Length of cold - to achieve - to maintain thermal shock	 ▪ < 30 seconds ▪ ≤ 30 seconds	 ▪ 30 seconds ▪ 30 seconds to 1 min	 ▪ 30 seconds to 1 min ▪ 1 min
Immediate aftercare	▪ Controlled exercise 30 minutes to 2 hours afterwards	▪ In the present state of knowledge best not associated with local care	▪ Touch as little as possible ▪ Double layer of bandaging for the members
Number and pattern of sessions	▪ one session daily 30 minutes to 2 hours before exercise	▪ one session daily after exercise, as soon as the hair and skin are dry	▪ 3 to 5 sessions at 45 minute intervals, then stop
Results and tests for effectiveness	▪ At T0 sensitivity disappeared	▪ At T 3 h, sensitivity, temperature, oedema, locomotion	▪ Retraction of the haematoma

***Photo 1**. Detection of superficial sensitivity in a horse's back, by light pressure and movement: this technique permits superficial trigger-points to be located. (Photo: F. Desbrosse).*

***Photo 2**. Detection of underlying pain in a horse's back by strong finger pressure, fixed and maintained: this technique also permits deep trigger-points to be detected. (Photo: F. Desbrosse).*

***Photo 3**. Identification of a muscle trigger point located in the muscles of the common mass by the palpating/rolling technique. (Photo: F. Desbrosse).*

***Photo 4**. Detail of the palpating/rolling technique; if rolling is easy to carry out at the level of the arm and head and semitendinous muscles, etc., it is more difficult with back muscles. Palpation is carried out by a controlled pinching between the thumb and the fingers, and rolling is done using the palm of the hand. (Photo: F. Desbrosse).*

The application of cold is carried out using a pistol that delivers carbon dioxide under pressure through a nozzle. This nozzle is held at a distance of three centimetres from the horse's skin to obtain thermal shock, then secondly, at a distance of six centimetres to maintain it. In man, the distances are five centimetres, then ten. Application is carried out with a sweeping movement across the area being treated, avoiding concentration on a fixed point. The action of the cold can be seen by the appearance of a visible frost on the surface of the skin, a frost composed of white dry-ice crystals (photo **6**).
The lowering of the temperature of the skin to four degrees is measured using a laser thermometer, which can be either incorporated into the pistol that delivers the carbon dioxide or separate. The speed of the sweeping motion is a determining factor, and determines the quality of the treatment. The speed should be adapted depending on the cooling of the skin and determined by the presence and persistence of the frost, and by the achievement of a temperature of 4^0C: where sweeping is too fast, the power of the cold is insufficient, and where sweeping is too slow, there is a risk of tissue lesion.
The application time required to obtain thermal shock is variable. It is about thirty seconds for the treatment of trigger points, splints and epiphysitis, etc.; it may be several minutes in cases of inflammation.
When a uniform temperature of 4^0C is reached on the surface of the skin to be treated, the action of the cold is maintained for a period of from thirty seconds, where it is simply a question of pain, to a minute, for inflammatory disorders.

Evaluation of the results of treatment

A few minutes after the application of cold, the effects are observable. So, when treating muscular trigger-points, relaxation of the muscles can be felt immediately.
During treatment of splints, pain on the application of pressure disappears in the minutes following treatment. To observe this, kinaesthetic sensitivity should be distinguished from nociception. Indeed, once the pain has been suppressed, kinaesthetic sensitivity reappears. This has an influence on the manner of palpating: detection of pain due to splints may be falsely negative if finger pressure is applied too soon while the phase of local anaesthesia is still active. Conversely, detection may be falsely positive in a situation of temporary blocking of sensation, secondary to the loss of sensation linked to the cryotherapy. In this type of situation, temporary hyperesthesia may set up around the area being treated. Detection of the pain may also be falsely interpreted as positive if the practitioner confuses the reflex arc induced by the return of kinaesthesia with the pain. To avoid all this, the member should be supported as it is palpated and stroked in the direction of the hair, before applying finger pressure to the splint. Locomotion should also be observed: limping disappears in the minutes following cryotherapy and may reappear within the following three hours. If this should occur, there

are two options possible: further sessions or cryosurgery. Cryosurgery is the cauterization of the periosteum by cold through the skin. In practice, a cryode, 6 mm in diameter containing liquid nitrogen is applied under local anaesthetic from thirty seconds to a minute, point by point on the splint. This technique is very effective but leaves white hairs.

***Photo 5**. Application of cryotherapy to a muscle trigger-point of the common mass. (Photo: F. Desbrosse).*

***Photo 6**. To achieve thermal shock, it is necessary to reach a temperature of 4^0C by sweeping the surface of the skin over a sufficient area. (Photo: F. Desbrosse).*

***Photo 7**. Checking the effects of thermal shock is carried out immediately afterwards. Here the surcingle test, with movement of the hindquarters to the left, is negated in the ten minutes following treatment, if treatment has been effective. (Photo: F. Desbrosse).*

***Photo 8**. Treating bursitis of the common extensor tendon of the toe, follow-up being carried out by measuring deformation, skin temperature, and the degree of movement in the fetlock. (Photo: F. Desbrosse).*

Glossary	
▪ **Ischemic compression**: application of progressively increasing and more and more painful pressure on a trigger-point, with the aim of suppressing the sensitivity of the point. ▪ **Anti-irritant**: anti-stimulant would be better. Practice aiming at masking a pre-existing focus of pain with pain caused intentionally. This mechanism proceeds from diffused inhibitor controls induced by nociceptive stimulation. ▪ **Deafferentation** (pain of): pain linked to a lesion of the peripheral nervous system, with interruption of sensation from the afferent pathways, and perceived outside any nociceptive stimulation (eg. amputation, shingles, polyneuritis, local/regional anaesthesia). ▪ **Referred pain** (from a trigger-point): Pain originating from a trigger-point but which is felt in an area some distance away, both specific and reproducible. ▪ **Facilitation**: a reflex that is established preferentially if the stimuli causing it are repeated. ▪ **Gate-control**: inhibition of spinal neurons involved in nociception by stimulation of large diameter fibres. This system also exists centrally.	▪ **Trigger-point**: an area of hyper-sensitivity in a tissue which, when pressure is applied to it is locally sensitive and gives rise to referred pain. ▪ **Raynaud's** (disease): paroxysmal disorder of the blood supply to the extremities, triggered by cold. ▪ **Myotatic reflex**: tonic contraction of the muscle caused by its own extension. ▪ **Myofascial pain syndrome**: Pain and/or referred neurovegetative phenomena accompanied by dysfunction, originating from an active trigger-point located within a muscle or in its fascia. ▪ **TENS**: Transcutaneous electrical nerve stimulation permitting pain relief. Depending on the setting, the effect is either of the "gate control" type, or of "diffused inhibitor control" type. ▪ **Reference area**: a specific region of the body, at a distance from a trigger-point, where the phenomena it produces are observed (sensitivity, motor, neurovegatative). ▪ **Tension areas**: (tension band or nodule): a group of muscle fibres under tension, related to a myofascial trigger-point and which can be detected when palpating the muscle.

The disappearance of referred pain may also be evaluated in the minutes following cryotherapy. This is the case for fascial and muscular trigger points [1, 15]. A situation that often occurs is that of back pain with a positive surcingle test, and the presence of a trigger-point distant from the surcingle. Several minutes after treating this trigger-point with cryotherapy, the surcingle test is repeated and locomotion observed (photo **7**). Several outcomes are possible:
- The test may be negative and locomotion normal: the trigger-point is responsible for the back pain, and the treatment is adjudged to have been successful.
- The surcingle and locomotion tests may be changed: the trigger-point may be considered only as being partially the cause of back pain and it is masking other causes that need to be diagnosed. The clinical examination should then be carried out more thoroughly, because in cases of back pain, one pain may mask another.
- The surcingle and locomotion tests are not modified: the trigger-point that has been treated may be considered as not participating directly in the back pain, with the reservation that the local effect (such as relaxation of the muscles) has been properly noted.

Observation of the effects of cryotherapy on inflammation requires examinations spaced out over a period of time. In the minutes following cryotherapy, a reduction in pain under finger pressure may be observed, accompanied by recovery of articular mobility, when it is a question of articulation. In the three hours following, a lowering of skin temperature and a reduction in the deformation may be noted (photo **8**). These latter parameters guide the rhythm of further sessions of treatment.
It appears, therefore, that the method of application of cryotherapy, and the observation of the effects obtained, permits progress in making a diagnosis and in the treatment of pain and inflammation.

Conclusion

Cryotherapy is a particular treatment, both analgesic and antalgesic, easy to carry out with horses, and tolerated well by the animal. First results are obtained rapidly and are clinically observable. However, this technique is new in relation to horses, and still needs to be validated. It seems more easily carried out in situations where the set-up of the treatment is well controlled and the protocols followed. This is the case for the treatment of back pain, lameness due to splints, severe inflammation requiring hospitalization and in postoperative treatment. Validation would seem less easy to carry out in situations where the equipment generating the cold is left for the trainer to use, where repeated treatments are required, as in the case of tendonitis, for example.

Summary

In horses, treatment for pain includes antalgesics such as non-steroidal anti-inflammatory drugs, and analgesics such as opioids, alpha-2 agonists, local anaesthetics, and acupuncture. Cryotherapy is both antalgesic and analgesic. The therapeutic action is due to the effects of thermal shock. These effects are mainly local anaesthetic, analgesic, vascular action, myorelaxant, anti-inflammatory and anti-oedematous. Thermal shock necessitates use of intense cold, under high pressure for a very short period. Carbon dioxide (pressure reduction at -78 °C) can have a strong effect when delivered under 50 bar of pressure. Thermal shock is thus obtained in the short time of 30 seconds to a few minutes and painlessly if the gas is completely dry. This method has a wide range of uses. These include back pain, splints, epiphysitis, contractures, arthritis, perioarthritis, tenosynovitis and bursitis, prevention of pain and inflammation post-operatively, tendonitis and haematomas. Five treatment protocols are discussed for these indications. Cryotherapy is useful for inhibition of myofascial relaxation and myofascial points are discussed in the article.

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