THE USE OF COLD INSTEAD OF HEAT FOR THE RELIEF OF MUSCLE SPASM[1]

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For centuries, man has appreciated the beneficial effects of heat in relieving pain, and various forms of heat have been widely used in physiotherapy techniques to ease pain and facilitate movement. However, the results in relief of muscle spasm have not been uniformly good In recent years, there has been increasing interest in the use of cold to relieve muscle spasm and pain. J. Travell (1949, 1952) reported on the use of cold in the relief of painful muscle spasm and regarded "trigger" points as of major importance. M. Ellis (1961) commented on the effect of cold in painful muscle spasm, and put forward the theory that relief was effected by bombarding the skin with such a barrage of cold impulses that the pain was obliterated, with a resultant relaxation in the restricted area. The relevant value of heat and cold in the treatment of muscle spasm has been reviewed recently by Don Tigny and Sheldon (1962).

Electromyography studies (Crue *et alii*, 1957) have shown a complete relaxation of normal voluntary muscles at rest. P. Matthews (1959) states that hypertonus is produced by an excessive discharge of the motor neurons supplying the main muscle fibres, and the gamma motor neurons supplying the specialized muscle fibres within the muscle spindles. The activity of the gamma motor neuron does not directly produce tension in the muscle, but increases the proprioceptive discharge of the muscle spindles, and this may cause contraction of the muscle by reflex excitation of the alpha motor neuron. Overactivity of the gamma motor neuron is therefore a major factor in the development of the hypertonus.

Local application of heat causes relaxation of muscles generally throughout the body (Basmajian, 1957), and local muscle spasm may be relieved; but the threshold of the local muscle spindles is not raised, and any attempt at voluntary motion will cause a return of muscle spasm. On the other hand, local application of cold raises the threshold of muscle spindles and increases relaxation, and even when exercise follows local application of cold, there is lowered neural activity. Eldred *et alii* (1960) reported that local cooling resulted in slowing down of the firing of muscle spindles and tendon organ endings under tension. It appears that local application of cold raises the threshold stimulus of the spindle, whereas heat lowers it. Bierman and Friedlander (1940) have shown that cold penetrates more deeply than most forms of heat.

For the past two and a half years at Hampton Hospital, we have therefore endeavoured to assess the value of the local application of cold in the relief of muscle spasm. The methods used are as follows.

THE USE OF ICE

Method 1: Packs soaked in ice and water at a temperature of 40° F. are applied to the skin, being changed every 45 seconds; about five packs in all are used.

Method 2: Affected hands or feet are immersed in a basin of ice and water at 34°F. This may be painful for a start, and the part may need to be withdrawn after 20 or 30 seconds. This action is repeated several times.

Method 3: Affected limbs are immersed in a bath of cold water and ice at a temperature of 34°F. for about four minutes.

SPRAY TECHNIQUE

Method 4: It was thought that the local use of an ethyl chloride spray was not desirable, because the agent freezes hard and is toxic and inflammable. We therefore used a fluoro-

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methane mixture ("Skefron") in a pressure-pack spray held 18 ins. from the skin and sprayed directly on the part for about five seconds. This was repeated twice at intervals of 30 seconds.

CONDITIONS TREATED

The Use of Cold in Multiple Sclerosis

The cold in this condition was applied as in Method 1 or Method 2. It was common to find that when spasticity was a major symptom, patients became capable of carrying out movements which had been difficult or impossible prior to the application of cold. At first relief was temporary, but it began to build up after several treatments.

Mrs. T., aged 45 years, suffering from spastic paraparesis due to multiple sclerosis, was referred to Hampton Hospital on June 7, 1961, from a paraplegia centre. At the paraplegia centre, considerable trouble had been encountered with this patient because of painful muscle spasm, and she had undergone bilateral obturator neurectomies and medial hamstring tenotomy. She had severe spasticity in the left knee and hip. She was unable to balance without support, and could walk only with a walking frame. By August 15, she could walk with two canes; she had sitting and standing balance for a few seconds only. By October 23, she could stand for five minutes. By November 21, she was able to walk with one cane. She was reviewed on September 25, at the referring paraplegia centre, which reported as follows: "It is noticeable how much better Mrs. T. is walking, and a major contribution appears to have been through the use of cold in relieving muscle spasm."

Mr. P., aged 60 years, suffering from multiple sclerosis, was admitted to Hampton Hospital on June 14, 1960. Because of spasticity in his left quadriceps, he was unable to bend his knee. He had a spastic foot drop with an ankle clonus. By July 11, he was able to bend his knee, and spasticity was much less. By August 23, there was further improvement, and he was able to commence half-time work.

In all cases of multiple sclerosis, the use of ice was combined with re-education by means of proprioceptive neuro-muscular facilitation techniques.

In our experience, it is common to find that these patients, are much worse in hot weather — so much so that we try to avoid admitting such patients to the hospital during the hot summer months.

Walters *et alii* (1960) reported that in studying the effect of heat and cold on work output, it had been found that 75% of the subjects did more work after the application of cold. It seemed logical therefore that cold might increase endurance.

Kabat (1947) has stated that the prolonged inactivity associated with multiple sclerosis may in itself play a large part in the progressive deterioration in muscle strength, beyond the extent of old lesions and the formation of new plaques in the central nervous system.

An example of this was Mrs. H., a sufferer from multiple sclerosis for ten years. When she came to us over two years ago, we gave her a cold bath, after which she was able to walk with more ease and less inco-ordination, and said that she felt less fatigued. Indeed, of her own volition, so pleased was she by this, that during hot summer days she wore a bathing gown to do her housework, and took frequent cold showers whenever she felt unduly fatigued. After a course of treatment, she has reported back at intervals, and states that she has greater muscle strength and endurance than when she first came to us two years ago.

We have found that cold baths do help to reduce fatigue in some of these cases of multiple sclerosis. Although there is little scientific backing for this, we have found, along with other workers (Boynton *et alii*, 1959; Bassett and Lake, 1958), that a temperature between 70° and 80°F. appears to be low enough to relieve fatigue, though lower temperatures are required to relieve spasticity.

Clarke, Lind and Hellon (1958) postulate that above a muscle temperature of 80°F. there is a rapid increase in metabolism resulting in a fast accumulation of metabolites, causing fatigue.

We have found that, in dealing with spasticity, we need to use lower temperatures than are required to relieve fatigue, and we have used a temperature of about 36°F. for approximately four minutes.

At the California Rehabilitation Centre at Vallejo, Margaret Knott advocates that the temperature should be below 58°F. We should stress that cooling alone will not bring lasting relief from spasticity; but it is a useful method for obtaining relaxation and thus permitting effective muscle re-education techniques.

In multiple sclerosis, by using the combination of ice cooling and proprioceptive neuro-muscular facilitation techniques, we have consistently found that cold diminishes spasticity, decreases irritability of the stretch reflex, increases ability to perform voluntary motion, increases co-ordination and increases performance in standing and walking, and in our experience, the use of proprioceptive neuro-muscular facilitation techniques after the preliminary use of ice cooling has been extremely valuable.

TRAUMATIC CONDITIONS

The second group of conditions we have treated comprises acute trauma, muscle and ligament sprains. In the few cases we have treated, the local application of cold has been particularly beneficial in reducing swelling and pain, especially if it is used early.

Thorndyke (1962) advocates the application of cold in the emergency initial treatment of muscle and ligament sprains. He comments that to secure maximum benefit, it is essential for moist cold to be in contact with the skin. Our experience agrees with this.

The advantage of the local application of cold instead of heat in the initial treatment of acute muscle and ligament sprains is that there is no risk, as there is with heat, of increasing haemorrhage.

MOBILIZATION OF STIFF JOINTS

Our third use of cold has been in assisting the mobilization of stiff joints.

Mr. L., aged 60 years, presented with a three months' history of pain and stiffness in the right shoulder, which was almost completely frozen. X-ray examination revealed no abnormality. Treatment was begun with the local application of cold and proprioceptive neuro-muscular facilitation re-education techniques, on June 14, 1961. At that time, his range of movements was as follows: flexion, 95°; abduction, 80°; external rotation, 110°; internal rotation, 40°. By July 12, he was free of pain, and the measurements were then as follows: flexion, 164°; abduction, 160°; external rotation, 145°; internal rotation, 20°.

It is hard to assess how this man would have responded had he been treated with heat instead of cold; but his recovery did seem to be quicker than usual in this type of case.

Two other cases give a clearer picture of the respective benefits of heat and cold applied locally in at least some cases.

Mr. M., a labourer, suffered a compound fracture of the right leg on August 31, 1959, and his leg was in plaster until December 22. After this, he had treatment at home, with simple application of heat and exercise. He was admitted to Hampton Hospital on March 7, 1960, the main problem being swelling of his right leg with stiffness of his knee and ankle. At this time, knee flexion was 110° and extension 170°, and the circumference of his right calf was 18 in. He received treatment with short-wave diathermy, massage and exercises until April 15, 1960. At this stage, the circumference of his calf had not altered, and the range of knee movements had altered to flexion 92° and extension 171°. In other words, there had been very little improvement. Treatment was begun with the local application of ice packs and re-education exercises on April 22, 1960. By May 13, his calf circumference had reduced to $16\frac{1}{4}$ inches, and flexion of his knee had improved to 78°. Treatment was continued, and on July 12, he was discharged from hospital when his calf circumference was $15\frac{3}{4}$ in., and his knee flexion 75°.

It seemed clear, in this case, that when the local application of heat and exercises failed, ice therapy together with re-education exercises succeeded.

Another case was that of Mr. T., aged 53 years, who was admitted to Hampton Hospital on February 8, 1960. On October 6, 1959, he had been involved in a motor car accident, and had sustained severe injury to the internal ligaments of his left knee, and he had undergone a left popliteal artery graft operation. On his admission to hospital, the range of movement at his left knee was: flexion, 101°; extension, 175°. The circumference of his

thigh was 19¾ in. and of his calf 17 in., compared with corresponding measurements on the normal limb of 18¾ in. in the thigh and 15 in. in the calf. He received treatment with the application of heat, massage and exercises, and by April 14, there had been no change in the measurements of his thigh or his calf, but knee flexion had improved to 80°. Treatment was begun with the local application of ice packs and re-education on April 16. By May 6, knee flexion had improved from 80° to 70°, and the circumference of his left thigh had been reduced to 19 in. and of his left calf to 15¾ in.

These few cases illustrate that sometimes mobilization of a stiff joint is more effective if it is preceded by the local application of cold rather than heat. We presume that when stiffness is produced by adhesions only, the local application of heat and mobilization are probably the usual effective measures, but that when there is any element of muscle spasm, the local application of cold would seem preferable to heat as a preliminary to mobilization.

It is of interest, in the last case, particularly, that troublesome swelling seems to have been reduced by the local use of cold.

STIFFNESS IN THE HANDS

The last group of conditions we have treated has comprised stiffness in hands following injury and/or surgery.

Our experience is too early yet to allow us to report in any definite manner on this, but we have already found a few cases in which heat with careful re-education has proved less effective than cold followed by re-education, and we intend to pursue the further local use of cold in these cases of hand disability.

CONCLUSION

In summary, we conclude that the local application of cold combined with proprioceptive neuro-muscular facilitation rehabilitation techniques is the most effective measure we have found in the treatment of multiple sclerosis.

We have also found that, when mobilization of a joint is required, if there is any muscle spasm, then it seems preferable to precede re-education techniques by the local application of cold rather than heat.

The local application of cold would seem to be the ideal emergency measure in the initial treatment of acute muscle and ligament strains.

It is our experience that, to be effective, cold therapy must consist of moist cold applied to the skin itself. The two methods available are either a spray technique or the use of ice and water. If the spray technique is used, then a fluoromethane spray, such as "Skefron," seems on all grounds far preferable to spraying with ethyl chloride; it has the advantage of being applied easily to any site. However, when muscle spasm is severe, we believe that the use of packs soaked in a mixture of ice and water seems to produce more lasting benefit than the local use of a cooling spray.

It is realized that this is not in any way a critical report; rather is it in the nature of a preliminary report, to draw attention to the possible local uses of cold, and to stimulate interest to further clinical research into this problem.

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