Superficial Heat Therapy

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Contributor: Jürgen Freiwald

Low back pain (LBP) is an exceptionally common musculoskeletal problem and a leading cause of disability. LBP is experienced by most adults at some stage of their life, with an estimated 577 million people affected in 2017. A recent systematic literature review stated that the prevalence of LBP ranges from 1.4% to 20.0%, and the incidence from 0.024% to 7.0%. The review focused on the application and effect of mild superficial heat for musculoskeletal pain, especially back pain. The review was able to show that the application of mild heat is easily applicable and effective when indicated.

Keywords: heat therapy ; low-back pain ; musculoskeletal pain ; non-pharmacological management

1. Introduction

Low back pain (LBP) is an exceptionally common musculoskeletal problem and a leading cause of disability [1]. LBP is experienced by most adults at some stage of their life, with an estimated 577 million people affected in 2017 [1]. A recent systematic literature review stated that the prevalence of LBP ranges from 1.4% to 20.0%, and the incidence from 0.024% to 7.0% [2]. LBP significantly impacts patients' quality of life, limiting their daily activities and work productivity. Non-specific LPB therefore represents a substantial clinical and economic burden, and is a major public health concern [1][3][4][5][6][7].

LBP is usually self-limiting, resolving in one to two months in most patients. Treatments for non-specific LBP include both pharmacological and non-pharmacological interventions [8]. Although over-the-counter, non-steroidal, anti-inflammatory drugs are frequently used as a first-line treatment for LBP [9][10], they carry the potential risk of cardiovascular, renal, hepatic, and gastrointestinal complications, particularly when used longer term [11]. It should also be noted that LBP affects patients with different comorbidities, which may place limitations on the use of concomitant pharmacological therapies [12].

The current guidelines for patients with mild-to-moderate LBP that does not limit everyday activity recommend that patients self-treat or use alternative, non-pharmacological treatments, such as superficial heat, massage, acupuncture, or spinal manipulation as initial or complementary options [8][13]. Heat therapy has been used for centuries to relieve pain and promote health [14][15] and is applied today in a variety of forms, including heat pads or wraps, hot baths, and heat lamps [16][17]. These modalities act at different depths, with the collective action of reducing the muscle tone, increasing blood flow, and relieving pain [17][18]. Continuous, low-level heat therapy is an effective, easy-to-use, low-cost option that could be a valuable part of a multimodal analgesic strategy in current clinical practice, and is a useful treatment that patients can easily and safely self-administer [19].

This narrative review summarizes the role of superficial heat therapy for the management of both acute and chronic non-specific LBP, focusing on the use of continuous, low-level heat therapy administered directly to the skin via a heat wrap for patients with mild-to-moderate LBP based on published studies and our collective clinical experience.

2. Causes of Low Back Pain

LBP results from—among other factors—activation of nociceptors in response to trauma, tissue damage, or mechanical action on the spinal cord and spinal nerves, as well as changes in (inflammatory) metabolism. Specialized, group III or group IV free nerve endings (nociceptors) are polymodal [20][21], reacting to both mechanical influences and inflammatory processes. These free nerve endings can produce inflammatory mediators themselves (neurogenic inflammation amplification), which leads to a lowering of the receptor threshold and an amplification of pain (peripheral pain sensitization) beyond the primary cause [21].

Neurotransmitters elicit changes in the interneurons of the spinal dorsal horns that influence their permeability, switching, and guidance mechanisms, which, in turn, affects the way they relay stimuli (including pain) [22][23][24][25][26]. Depending on their location and the cause of the activation of the pain receptors, there may be a local increase in the tone of the segmentally assigned muscles, with the formation of trigger points. A permanent change of the paravertebral muscle tone and the development of trigger points can lead to further pain intensification and can result in a vicious circle of pain amplification. In this context, Petrofsky et al. [27] showed that, when locally applied to trigger points, heat is significantly superior to sham treatment for non-specific neck pain.

Although the cause of LBP is often non-specific, extensional and rotational-shear forces acting on the spine can activate mechanical and polymodal pain receptors—especially in spinal segments with pre-existing damage. The activation of nociceptors alters neuromuscular activation, resulting in muscle inhibition and contributing to a degenerative cascade, which ultimately results in pain and limits the patient's ability to move [28][29].

Left untreated, a persistent stimulus can drive the transition from acute pain to chronic pain via a series of distinct pathophysiological steps. Persistent pain can activate secondary pathways that lead to peripheral and central sensitization, hindering normal functioning via long-lasting modification of the neuronal cytoarchitecture and loss of inhibitory interneurons [30][31]. It is therefore important that acute episodes of LBP are addressed in a timely manner, and within the "window" in which permanent changes may occur, to inhibit the transition to chronic pain [17][30]. Additionally, both chronic and recurrent LBP can be associated with changes in the structure and function of the paraspinal muscles (e.g., muscle degeneration and fat infiltration) that can compromise normal muscle biomechanics and restrict movement; however, discussion of these musculoskeletal changes is beyond the scope of this article.

3. Overview of Superficial Heat Therapy Modalities

Heat therapy is the therapeutic application of heat to the body that results in an increase in tissue temperature [17]. The mode of therapy can be superficial, delivered using conduction (e.g., heat wraps or heat packs) or convection (e.g., hydrotherapy) techniques, or deep, delivered by conversion methods (e.g., ultrasound, diathermy, and laser therapy). **Table 1** summarizes the range of superficial low-level heat modalities available, all of which aim to provide pain relief and muscle relaxation/reduction in muscle spasms via the mechanisms described in the previous section [17][18]. Details on each of these heat therapy modalities and their specific applications are beyond the scope of this article, which is focused on the use of heat wrap therapy.

Table 1. Types of superficial heat therapy used to treat acute or chronic back pain.

	Method of Heat Application	Type of Therapy
Superficial heat therapy	**Conduction**	**Heat wrap (wearable)** **Heat pack (grain)** **Hot water bottles** **Hot poultices** **Hot stone therapy** **Electric heat pads**
	Convection	**Hydrotherapy** **Hot baths** **Heat lamp** **Stream/sauna**

One advantage of superficial heat therapy is its safety profile. In a Cochrane review of nine studies, superficial heat therapy was associated with only minor adverse events, mostly in the form of "skin pinkness" that resolved quickly [16]. Despite this, the use of superficial heat therapy, especially at high temperatures, may carry the risk of burns or skin ulceration. Furthermore, in some specific causes of pain, it may cause disease complications, progression, or exacerbation of inflammation. Therefore, caution is required in any condition with sensory impairment, such as multiple sclerosis, spinal cord injuries, autoimmune diseases with joint pain, activated osteoarthritis, poor circulation, and cancer [32][33].

4. Evidence of the Effectiveness of Continuous Low-Level Heat Wrap Therapy for Low Back Pain

In a prospective study, patients with acute, non-specific LBP were randomized to receive continuous low-level heat wrap therapy for 8 h/day ($n = 113$), acetaminophen ($n = 113$), or ibuprofen ($n = 106$). Pain relief was reported in all three treatment groups, and was significantly greater with heat wrap therapy than with acetaminophen or ibuprofen throughout two days of treatment ($p < 0.001$ for all) and two days of follow-up ($p < 0.001$ for all). This translated into significant differences in pain relief scores of 33% for heat wrap vs. acetaminophen and 52% for heat wrap vs. ibuprofen. The heat wrap group also experienced significantly greater reductions in muscle stiffness and significantly greater improvements in lateral trunk flexibility and disability scores vs. the acetaminophen and ibuprofen groups after both the treatment and follow-up periods [34].

In two workplace studies, heat wrap therapy was found to significantly reduce pain intensity in patients with acute LBP, both during treatment and up to two weeks after its use [35][36]. Heat wrap therapy also reduced the impact of pain on everyday activities, most notably the ability to lift, work performance, and quality of sleep, and provided sufficient pain relief for most patients during treatment and two weeks after its use [35].

There were no serious adverse events reported in any of the aforementioned studies, and heat wrap therapy was found to be well tolerated in all of the studies mentioned [34][37][38][36][39].

Cost-effectiveness analyses have shown that the use of heat wrap therapy for the management of LBP is beneficial to both healthcare systems [40] and employers [35]. Economic modeling of the heat wrap vs. acetaminophen vs. ibuprofen study described above [34] indicates that introducing heat wrap therapy in place of oral treatments would provide material savings to the U.K.'s National Health Service [40]. Furthermore, a pharmacoeconomic analysis has demonstrated the improved workplace productivity, and subsequent benefit to employers, associated with heat wrap therapy [35].

5. Other Applications for Superficial, Low-Level Heat Therapy

The muscle relaxant and analgesic effects of superficial low-level heat therapy (as reviewed in the section above) have also been found to be efficacious in relieving other types of musculoskeletal pain. Several studies have reported the benefits of continuous, low-level, direct heat wrap therapy for the treatment of neck pain [27][41], knee pain (including pain from osteoarthritis, where a heat wrap was more effective than acetaminophen) [41][42][43][44], and wrist pain stemming from strain or sprain, tendinosis, and carpal tunnel syndrome, with particularly good results observed in patients with carpal tunnel syndrome [45].

Localized heating of certain trigger points has also proven effective at relieving neck pain; in this case, the heat is applied on the upper trapezius muscle [27]. Studies have also indicated that heat therapy is effective at preventing and treating delayed-onset muscle soreness associated with exercise, with benefits observed in younger and older patients, as well as those with diabetes (a group who reportedly experience greater muscle soreness after exercise) [41][46][47][48]. In addition, the application of heat therapy for 8 h, including the 4 h before exercise, was found to be significantly more effective than stretching at preventing pain and improving disability and physical function the day after exercise [46]. Further to this, studies have also indicated that heat therapy provides greater benefits than cold therapy when applied after exercise [46][47][48][49].

Heat wraps as a method of heat therapy for pain relief have shown the key advantage of wearability, which allows for continuous use and the rapid resumption of work/normal daily activities. This feature makes it particularly relevant for other areas of pain management, such as dysmenorrhea, where it has demonstrated pain relief comparable to that achieved with ibuprofen [50][51]. Heat therapy may also be beneficial as part of a long-term pain management strategy following some surgical procedures [52].

6. Conclusions

LBP exerts a substantial burden on patients and is recognized as a major public health concern. Early treatment can help to inhibit the transition from acute to chronic LBP. Several clinical trials have demonstrated that continuous, low-level heat therapy, used alone or as part of a multimodal approach, provides early pain relief and improves muscular strength and flexibility, facilitating a return to normal function in patients with either acute or chronic LBP. Although improvements seen with superficial heat therapy can be short-term, local heat therapy can have a valuable role in current clinical practice, particularly for complex clinical cases, such as elderly patients with multiple comorbidities who are already receiving several concomitant medications, and in the outpatient setting for the preparation and follow-up of back pain therapies. In patients with mild LBP, heat therapy may potentially negate the use of pain medications, and in patients with moderate-to-severe pain, heat therapy may help lower pain drug requirements (i.e., number and dose).

In conclusion, continuous, low-level superficial heat therapy is an effective, safe, easy-to-use, and cost-effective non-pharmacological pain relief option that patients can easily self-administer, proving that a therapy known for centuries still has a relevant role in clinical practice today.

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