Available online at
SciVerse ScienceDirect
www.sciencedirect.com
Elsevier Masson France
EM|consulte
www.em-consulte.com
Annals of Physical and Rehabilitation Medicine 55 (2012) 229–240
ANNALS OF PHYSICAL AND REHABILITATION MEDICINE

Original article / Article original

Comparison of gaseous cryotherapy with more traditional forms of cryotherapy following total knee arthroplasty

Comparaison de la cryothérapie gazeuse à des formes de cryothérapie plus traditionnelles après arthroplastie totale du genou

C. Demoulin [a,*,b], M. Brouwers [a], S. Darot [a], P. Gillet [c], J.-M. Crielaard [a,b], M. Vanderthommen [a,b]

[a] *Department of Motricity Sciences and Rehabilitation, Liège University, Allée des Sports 4, 4000 Liege, Belgium*
[b] *Department of Physical Medicine and Rehabilitation, Liège University Hospital (CHU), Liege, Belgium*
[c] *Department of Orthopaedic Surgery, Liège University Hospital (CHU), Liege, Belgium*

Received 4 July 2011; accepted 13 March 2012

Abstract

Objective. – The aim of this study was to assess the efficacy of gaseous cryotherapy following total knee arthroplasty (TKA) and to compare it to routinely used strategies for applying cold therapy.
Patients and methods. – Sixty-six patients undergoing primary unilateral TKA were randomized into three groups and received ''gaseous cryotherapy (GC)'', ''cold pack'' and ''cryocuff'' applications, respectively throughout the hospital stay. Primary outcomes (knee pain intensity, mobility and girth measurements) were recorded on preoperative day 1 as well as on postoperative day (POD) 7. Cutaneous temperature of the knee sides were also measured on POD7 just before and immediately after cold application.
Results. – Although skin temperature dropped to 14 °C following GC versus 22 to 24 °C for the other two applications ($P < 0{,}05$), the three groups did not differ at POD7 regarding the three primary outcomes. No adverse effects were observed with any of the ways of application.
Conclusions. – Gaseous cryotherapy was not more beneficial than routinely used strategies for applying cold therapy. Further studies with larger sample size and with a more frequent and closer gaseous cryotherapy applications are needed to confirm our results.

Keywords: Cryotherapy; Cold; Total knee replacement; Pain; Mobility

Résumé

Objectif. – Évaluer l'efficacité de la cryothérapie gazeuse après prothèse totale de genou (PTG) et la comparer à des modalités traditionnelles d'application thérapeutique du froid.
Patients et méthodes. – Soixante-six patients programmés pour une PTG unilatérale primaire ont été randomisés en trois groupes qui ont bénéficié respectivement de « cryothérapie gazeuse » (CG), d'un « cold pack » et du « cryocuff » au cours de leur période d'hospitalisation. L'intensité de la douleur et les mesures périmétriques, et de mobilité du genou, qui constituaient les variables principales, ont été enregistrées la veille de l'intervention chirurgicale ainsi que sept jours après l'intervention (J + 7). La température cutanée du genou a également été mesurée dans les trois groupes à J + 7, juste avant et après l'application du froid.
Résultats. – Bien que la température cutanée ait chuté jusqu'à 14 °C suite à la CG versus 22 à 24 °C pour les deux autres formes d'application ($p < 0{,}05$), les trois groupes expérimentaux ne différaient pas significativement à J + 7 en termes d'intensité de la douleur, de mobilité et de mesures périmétriques. Aucun effet secondaire n'a été observé au sein des trois groupes expérimentaux.
Conclusions. – La cryothérapie gazeuse ne s'est pas révélée plus efficace que des modalités traditionnelles d'application thérapeutique du froid. Des études complémentaires sur des échantillons plus larges, avec une application plus fréquente et une pulvérisation plus proche, sont nécessaires pour confirmer ces résultats.

Mots clés : Cryothérapie ; Froid ; Prothèse genou ; Douleur ; Mobilité

* Corresponding author.
E-mail address: christophe.demoulin@ulg.ac.be (C. Demoulin).

1877-0657/$ – see front matter
doi:10.1016/j.rehab.2012.03.004

1. English version

1.1. Introduction

Cold has been long known to have therapeutic effects: Hippocrates reported use of ice or snow to reduce edema formation and pain about 400 years before Christ [37]. Nowadays, it is extensively used and is considered to be a key treatment for various acute injuries. Use of cold therapy (cryotherapy) has long been empirical. Although several studies have been conducted on the topic, numerous questions and controversies remain regarding its effects and the optimal ways to use it [24]. Such discrepancies result from the significant heterogeneity between studies, which prevents comparative study, and from the low number of controlled and randomized studies [5].

Literature [10,17,31] reports several physiologic effects of cryotherapy including reduction of skin [9,24], muscle [24] and articular [26,32] temperature, vasoconstriction of skin blood vessels [10] leading to decrease in blood flow [19], and reduction of the inflammatory process resulting from decrease of tissue metabolism and from reduction in enzymatic activity [10]. Application of cold also induces analgesia by means of an anti-nociceptive effect on the gate control system and the decrease of nerve conduction speed [10,14] as well as prevention/reduction of post-traumatic edema and blood loss in post-surgical patients thanks to a decrease of vascular permeability and the vasoconstriction [17,40].

Various cooling mechanisms or devices used in clinics or on the sports field have been reported in the literature [10,28]. Gaseous cryotherapy is one of them; this sophisticated cold application is based on the projection of CO_2 microcrystals under high pressure [8,13,30] (CO_2 is now used instead of nitrogen-cold air [33,34]). This technique is supposed to decrease skin temperature [30] to a greater extent than an ice bag and cause a more pronounced ''thermal shock''; Mourot et al. also observed that gaseous cryotherapy triggered a systemic cutaneous vasoconstriction response [30]. According to Chatap et al., hyperbaric CO_2 cryotherapy can also decrease pain scores in elderly inpatients with acute or chronic pain [8]. However, no other studies have investigated the clinical benefits of hyperbaric gaseous cryotherapy. Thus, no published data are available regarding its benefits following total knee arthroplasty (TKA), which is a frequent surgical option to treat patients with end-stage knee osteoarthritis (OA) [4,23].

Although cryotherapy is used most of the time in post-surgical patients, there is no consensus regarding the optimal method of application i.e. forms of cryotherapy, temperature and frequency application, etc. [1,3] and the specific management of cryotherapy after TKA [3]. The need for further research stated in a survey on current practice of cryotherapy after TKA [3] is confirmed by recent literature reviews on this topic [1,25].

Accordingly, the aim of the present work was to study whether gaseous cryotherapy is more effective in the post-operative care of people with TKA than routinely used cold application strategies i.e. cold gel packs or the Cryocuff®.

1.2. Patients and methods

1.2.1. Participants

This prospective study concerned patients who were undergoing primary unilateral (TKA) in the Liège University Hospital. Patients were eligible for the study according to the following inclusion criteria: age between 40 and 85 years, severe osteoarthritis requiring a TKA. The exclusion criteria were: severe varus or valgus deformity, not proficient in French, rheumatoid arthritis, as well as major associated medical problems such as peripheral vascular disease, associated acute pathology, cold urticaria, and Raynaud's phenomenon.

All patients received a low contact stress (LCS) prosthesis (De Puy, Johnson and Johnson) and were operated on by a senior orthopaedic surgeon with an anteromedial approach of the knee joint. A tourniquet was used in all patients and devascularisation of the leg lasted 45 to 55 minutes.

All patients gave written informed consent to participate. The medical ethics committee of the Liège University Hospital approved the study protocol.

1.2.2. Experimental design/procedure

On preoperative day 1 (PreOD1), patients were randomized into three groups using a computer generated table of random numbers; these groups differed by the main method that was going to be used to apply cold therapy throughout the hospital stay.

In the ''gaseous cryotherapy'' group (GC), a Cryotron™ device (Cryonic Médical, Salins-les-Bains, France) was used. This device consists of medical-grade liquid CO_2 in a cylinder equipped with an electrovalve and an immersed tube, a spray gun, and a nozzle. The CO_2 is sprayed on dry skin over the knee using a slow, regular, sweeping movement. A pistol fitted with a laser-guided infrared measurement system allows to control instantaneously the degree of skin cooling. A light switches on when the skin temperature drops to about 4 °C in order to avoid a risk of frostbite. As recommended by the manufacturer, the tip of the nozzle was kept 15 to 20 cm away from the skin. Gaseous cryotherapy provides painless (dry gas) air under high pressure (50 Bar) at a very low temperature (−78 °C) which causes the skin temperature to fall very quickly. Hyperbaric CO_2 cryotherapy was applied to patients for 90 seconds (30 seconds over the internal side of the knee, 30 seconds over the other side and 30 seconds over the popliteal fossa). The CO_2 was sprayed three times per day.

In the ''cold pack'' group (CP), a traditional ''gel pack'' (Physiopack®) (width 13 cm, length 30 cm, weight 400 g) was frozen for a minimum of 2 hours before application. The gel pack was placed transversally over the knee and secured with an elastic wrap. A towel was used as a barrier to prevent frostbite. The gel pack was applied to patients for 20 minutes, five times a day.

The ''cryocuff'' group (CC) was treated with a water-circulating device (Aircast® Cryocuff®, Inc., Summit, New Jersey) combined to the AutoChill® System (Aircast®, Inc., Summit, New Jersey) to provide cold and focal compression. A specific cuff surrounding the knee with pressurized ice water is