Journal Pre-proof

Effect of cryotherapy on pain and analgesic consumption after wrist or thumb surgery

M. Pouedras, A. Blancheton, H. Agneray, V. Crenn, P. Bellemère

PII: S2468-1229(20)30236-X

DOI: https://doi.org/10.1016/j.hansur.2020.09.009

Reference: HANSUR 1196

To appear in: *Hand Surgery and Rehabilitation*

Received Date: 29 June 2020

Revised Date: 29 September 2020

Accepted Date: 30 September 2020

Please cite this article as: { doi: https://doi.org/

Effet de la cryothérapie sur la douleur et la consommation d'antalgiques après chirurgie du poignet ou de la base du pouce

Effect of cryotherapy on pain and analgesic consumption after wrist or thumb surgery

M. Pouedras[1], A. Blancheton[1], H. Agneray[1], V. Crenn[2], P. Bellemère[1]

1: Institut de la Main Nantes-Atlantique, Santé´Atlantique, Avenue Claude Bernard, 44800 Saint-Herblain, France

2: Service de Chirurgie Orthopédique et Traumatologique, CHU Nantes, 1, place Alexis Ricordeau, 44093 Nantes Cedex 1, France

3: Inserm UMR 1238, Bone sarcomas and remodeling of calcified tissues, 3, chaussée de la Madeleine, 44000 Nantes, France

Corresponding author.

Marie Pouedras, Resident

Institut de la Main Nantes-Atlantique, Santé´Atlantique, Avenue Claude Bernard, 44800 Saint-Herblain, France.

Email address: marie.pouedras@gmail.com

Tel :+33 668792097

Other authors:

Aurore Blancheton, Resident

Hélène Agneray, MD

Vincent Crenn, MD

Philippe Bellemère, MD

Conflits d'intérêts

Les auteurs déclarent ne pas avoir de conflit d'intérêt

.

Résumé

La cryothérapie a depuis longtemps démontré son efficacité sur les douleurs post-traumatiques des parties molles via notamment son action anti-inflammatoire. Son utilisation post-opératoire a également fait l'objet de nombreuses études et a désormais fait ses preuves dans certaines indications comme la chirurgie ligamentaire ou prothétique du genou. Le but de cette étude était d'analyser l'effet de la cryothérapie sur les douleurs et la consommation d'antalgiques dans le cadre de la chirurgie de la main. Nous avons inclus prospectivement 60 patients entre mars 2017 et mai 2018. Tous ces patients ont eu une intervention au niveau de la base du pouce ou du poignet comportant un geste osseux. Trente patients ont été inclus dans le protocole de cryothérapie avec l'attelle Handfreez®, 30 patients ont été inclus dans le groupe contrôle avec une immobilisation standard. Le recueil de données concernait la douleur évaluée sur une échelle visuelle analogique (EVA), la consommation d'antalgiques et anti-inflammatoires non stéroïdiens (AINS), pendant l'hospitalisation, puis à domicile durant une semaine. Les résultats ont été comparés entre les deux groupes. Pendant l'hospitalisation, la consommation de morphine était significativement inférieure dans le groupe cryothérapie (p=0.04). A domicile, la consommation d'AINS était significativement inférieure dans le groupe cryothérapie (p=0.009). Nous n'avons pas mis en évidence de différence significative sur l'EVA entre les deux groupes. Nous avons démontré dans notre étude le bénéfice de la cryothérapie sur la consommation post-opératoire d'antalgiques et d'AINS suite à une chirurgie osseuse du poignet ou de la base du pouce.

Mots-clés : Cryothérapie ; Chirurgie de la main ; Antalgie

Abstract

Cryotherapy has demonstrated its efficacy in post-traumatic soft tissue pain, through its anti-inflammatory action. Its postoperative use has also been the topic of many studies and has now proved its efficacy in indications such as ligament or knee arthroplasty surgery. The aim of this study was to analyze the effect of cryotherapy on pain and analgesic consumption after wrist or base of the thumb surgery. We prospectively included 60 patients from March 2017 to May 2018. All these patients had undergone wrist or base of the thumb surgery involving a bone procedure. Thirty patients were managed with cryotherapy (the Handfreez® splint), 30 patients were included in the control group with conventional immobilization. The data collected included a visual analogue scale (VAS), and analgesic and non-steroidal anti-inflammatory drug (NSAID) consumption, both during the hospital stay and then at home for one week. The results from the two groups were compared. During the hospital stay, morphine consumption was significantly lower in the cryotherapy group (p=0.04). At home, NSAID consumption was significantly lower in the cryotherapy group (p=0.009). The VAS score was not significantly different between the two groups. In our study, we demonstrated the benefits of cryotherapy on consumption of analgesics and NSAIDs after bone surgery of the wrist or the base of the thumb.

Keywords: Cryotherapy; Hand surgery; Pain relief

1. Introduction

Cryotherapy has been used for many years to relieve pain following trauma to bones or soft tissues. Historically, treatment based on local cryotherapy was first described by Hippocrates for its analgesic, anti-edematous and muscle relaxing properties [1]. Today, the RICE protocol (Rest, Ice, Compression and Elevation), modified a few years ago to become PRICE (Protection, Rest, Ice, Compression and Elevation), is considered the reference treatment in sports medicine for managing trauma to soft tissues in the acute phase. It has proven its efficacy for many years [2–6]. In 2011, Bleakley et al. proposed a new adjustment to the acronym: POLICE (Protection, Optimal Loading, Ice, Compression and Elevation) [7]. The authors recommended balancing rest and mechanical load during re-education, hence the term "Optimal Loading". It has effectively been shown that functional re-education implies an idea of mechanical load that is propitious for scarring [8].

The use of cold remains present in all these modifications. Via tissue hypothermia, cold makes it possible to decrease the local metabolism, and thus the production of pro-inflammatory enzymes and molecules. The cold also induces a slower nerve conduction velocity and vasoconstriction, leading to decreased blood flow and thus less pain and edema [9]. In their study published in 2017, Singh et al. analyzed in rats the effects of early cryotherapy on muscle trauma [10]. The parameters studied were inflammation and above all angiogenesis, revascularization, and muscle regeneration. As angiogenesis plays a key role in tissue regeneration [11,12], their hypothesis was that cryotherapy, by decreasing angiogenesis and inflammation, could slow down the regeneration of muscle fibers. Their results confirmed that cryotherapy decreased inflammation and certain aspects of angiogenesis and revascularization. However, these effects were not significant enough to lead to slower muscle regeneration one month after the trauma.

The beneficial effects of post-operative treatment with cold, such as less edema, less pain and less inflammation, have been described in the literature [13–15]. Other benefits, such as blood saving and quicker functional recovery have also been found [16,17]. Several studies have already shown its advantages in certain indication, such as after ligament

surgery or prosthetics of the knee [5,6] and shoulder [18,19]. Nevertheless, there is little literature on this subject in the context of hand or wrist surgery [20,21].

The aim of our study was to highlight the effects of cryotherapy in these indications. Cryotherapy could thus be an alternative to traditional immobilization by making it possible to save on analgesics and non-steroidal anti-inflammatory drugs (NSAIDs), which are responsible for non-negligible morbidity in patients.

2. Material and methods

We carried out a single center, prospective, comparative, controlled study. The patients were included continuously into the cryotherapy group, and then the control group, between March 2017 and May 2018. The surgical procedures retained for this study were those concerning the distal extremity of the radius, the carpus or the base of the thumb, and composed of a bone gesture: single trapeziectomy or with interposition of a pyrocarbon implant (Pyrodisk®), Amandys®, APSI®, or arthrodesis of the 4 bones. Only patients in conventional hospitalization for scheduled surgery were included. Thirty patients were included in the cryotherapy group with the Handfreez-Freezsnow® splint (Ambelio™, Rennes, France), composed of a removable wrist splint and a cryotherapy cold pack, and 30 patients were included in the control group with conventional immobilization (a thermoformed orthosis or a cast). The exclusion criteria were being aged under the age of 18 years, patients under guardianship, the association of several procedures during the surgical procedure and traumatology. For patients in the cryotherapy group, we also verified beforehand that there was no contraindication, such as intolerance of cold or Raynaud's syndrome. The patients were informed by the investigators before surgery of how the study worked and signed a consent form. All patients underwent surgery under local anesthetic. The axillary block was achieved with 30 to 40 mL of chirocaine (2.5mg/mL or 3.75mg/mL) associated with 8 mg of intravenous dexamethasone, when there was no contraindication.

The cryotherapy protocol was as follows: the cold pack and removable splint were positioned after bandaging, at the end of the operation. The cold pack was left in place for 2

hours and then removed by the unit nurse for 3 hours. The rhythm of using the pack continued in this way, with cycles of 2 hours of cryotherapy followed by 3 hours with the removable splint alone. During the night, the cold packs were not renewed. Analgesics were administered on request, depending on the pain felt by the patient, with a target Visual Analog Scale (VAS) score of less than 3, while respecting any intolerance and contraindications in each patient. During this first, hospitalization phase, the nurses collected the VAS score and noted consumption of analgesics and NSAIDs using a specific questionnaire. The analgesics were divided into three categories, corresponding to the different levels. The time at which the bloc wore off, as well as any adverse events were also noted. During the second phase, which took place at the patient's home, patients assessed their VAS several times a day (morning, midday, afternoon and evening) and their consumption of analgesics and anti-inflammatories daily, using a specific questionnaire, and for a duration of six days. This document was returned to the surgeon at the first post-operative follow-up visit.

For the control group with conventional immobilization, the thermoformed orthosis or cast was left in place. The same two questionnaires were filled in and returned in the same way.

Our primary aim was to assess the effect of cryotherapy on the VAS. Our secondary criterion was to assess the effect of cryotherapy on the consumption of analgesics or NSAIDs.

For the statistical analysis, the groups were compared on the parameters of the VAS and consumption of analgesics using Student's t-test. A *p*-value of less than 0.05 was considered to be significant. The statistics tests were carried out using SPSS Statistics software. Consumption of analgesics and NSAIDs was expressed as the cumulated number of times the drugs were taken by the patient. One intake corresponded to 1 g of paracetamol, 50 mg of tramadol (or any other level 2 analgesic), 400 mg of ibuprofen and 5 mg of morphine.

3. Results

3.1. Population

The average age of the patients was 64.3 years in the cryotherapy group and 62.5 years in the standard group. The patients were divided on the basis of normal distribution. The sex ration (male/female) was 0.38 in the cryotherapy group and 0.5 in the standard group. The most frequently performed surgery was the trapeziectomy alone or associated with the insertion of a pyrocarbon implant (Pyrodisk®). There was no significant difference between the two groups on the basis of these two criteria.

3.2. Consumption of analgesics and NSAIDs

The results for the consumption of analgesics and NSAIDs during hospitalization are presented in Table 1. We observed significant decrease in the consumption of morphine ($p=0.04$) in the cryotherapy group. On the other hand, we did not observe any significant difference concerning the consumption of level 1 or 2 analgesics or NSAIDs.

The results on the consumption of analgesics and NSAIDs at home are presented in Table 2. We did not observe any significant difference in the consumption of analgesics, although the consumption of NSAIDs on the other hand was significantly lower ($p=0.009$).

3.3. Visual analog scale:

We did not highlight any significant difference on the VAS for pain between the two groups, whether during hospitalization (Fig. 1) or at home (Fig. 2).

4. Discussion

The aims of this study were to compare the VAS score and the consumption of analgesics and NSAIDs between two groups of patients, one with a Handfreez® cryotherapy splint, the other with conventional immobilization. Our hypothesis was that cryotherapy may make it possible to better control any pain, while also making it possible to decrease the consumption of analgesics and NSAIDs. We were able to confirm this hypothesis with a

difference on the one hand in the consumption of morphine during hospitalization, and, on the other, consumption of NSAIDs at home, whereas the VAS remained comparable in both groups. This clinical efficacy was furthermore associated with very good tolerance: no adverse events and no patient left the study. The Handfreez® cryotherapy splint was effectively equipped with “gentle” cold packs (0 to 5°), which prevented skin burns, and a long duration of action (up to two hours), which made it possible to limit movements at the level of the operation site as much as possible. In addition, the cold packs were segmented and malleable, providing optimal adaptability to the morphology of the patient.

To our knowledge, this is the first study making it possible to highlight in a significant manner the beneficial effects of cryotherapy in the context of bone surgery of the hand and wrist. The other strong points of this study are the clinical relevance of our results, with usefulness for, and a direct impact on, practices, significant external validity, as well as the absence of patients lost to follow-up.

Our study nevertheless has several limitations. The absence of blinding was inherent to the cryotherapy protocol and may have had an influence on the patients. The immobilization in the control group was of two types: a thermoformed splint or a cast, whereas all the patients in the first group were immobilized by the cryotherapy splint. We did not make any distinction between these two possibilities for immobilization in the control group. The data collection (VAS and consumption of analgesics and NSAIDs) at home may have included inaccuracies or omissions, but the data collection protocol was identical in both groups. We can also regret the absence of randomization, the patients having been included consecutively first in the cryotherapy group and then in the control group. Finally, we can note the lack of power in the statistical tests, a PEDro scale at 4/10 (scale noted out of 10, composed of a checklist of 11 items, the aim of which is to assess the methodological quality of the study) and thus low internal validity.

In a study published in 2010, Meyer-Marcotty et al. compared the effects of cryotherapy combined with compression versus standard management (ice pack or crushed ice) after wrist arthroscopies in 52 patients [21]. The criteria studied were pain, edema, range

of motion in the joints and functional recovery (DASH score). This study did not make it possible to highlight any significant difference on the full set of criteria. As in many recent studies, Meyer-Marcotty et al. compared the effects of cryotherapy combined with compression with those of cryotherapy alone [20,22,23]. Intermittent dynamic compression improved oxygenation of the tissues, microcirculation, and the circulation of interstitial fluids in relation to permanent static compression [24]. However, the rhythm, duration, and mode of compression seem to date to be difficult to determine [2]. In our study, cryotherapy was not associated with compression. We also did not study the consequences of cryotherapy on edema and functional recovery.

5. Conclusion

With the same VAS for pain, we revealed a decrease in the post-operative consumption of analgesics and NSAIDs thanks to cryotherapy. A study on a larger number of patients would make it possible to increase the power of the study. The results in terms of functional recovery and the effects of cryotherapy associated with compression would also be interesting to analyze.

Human and animal rights

The authors declare that the work described has been carried out in accordance with the Declaration of Helsinki of the World Medical Association revised in 2013 for experiments involving humans as well as in accordance with the EU Directive 2010/63/EU for animal experiments.

Informed consent and patient details

The authors declare that they obtained a written informed consent from the patients and/or volunteers included in the article and that this report does not contain any personal information that could lead to their identification.

Funding

This work did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

The authors declare that they have no conflicts of interest.

References

1. Demoulin C, Vanderthommen M. Cryotherapy in rheumatic diseases. Joint Bone Spine 2012;79:117‐8.

2. Bleakley C, McDonough S, MacAuley D. The use of ice in the treatment of acute soft-tissue injury: a systematic review of randomized controlled trials. Am J Sports Med 2004;32:251‐61.

3. Hocutt JE Jr, Jaffe R, Rylander CR, Beebe JK. Cryotherapy in ankle sprains. Am J Sports Med 1982;10:316‐9.

4. Hubbard TJ, Aronson SL, Denegar CR. Does cryotherapy hasten return to participation? A systematic review. J Athl Train 2004;39:88‐94.

5. Hubbard TJ, Denegar CR. Does cryotherapy improve outcomes with soft tissue injury? J Athl Train 2004;39:278‐9.

6. Norton C. How to use PRICE treatment for soft tissue injuries. Nurs Stand 2016;30:48‐52.

7. Bleakley CM, Glasgow P, MacAuley DC. PRICE needs updating, should we call the POLICE? Br J Sports Med 2012;46:220‐1.

8. Khan KM, Scott A. Mechanotherapy: how physical therapists' prescription of exercise promotes tissue repair. Br J Sports Med 2009;43:247‐52.

9. Abramson DI, Chu LS, Tuck S Jr, Lee SW, Richardson G, Levin M. Effect of tissue temperatures and blood flow on motor nerve conduction velocity. JAMA 1966;198:1082‐8.

10. Singh DP, Barani Lonbani Z, Woodruff MA, Parker TJ, Steck R, Peake JM. Effects of topical icing on inflammation, angiogenesis, revascularization, and myofiber regeneration in skeletal muscle following contusion injury. Front Physiol 2017;8:93.

11. Huey KA, Smith SA, Sulaeman A, Breen EC. Skeletal myofiber VEGF is necessary for myogenic and contractile adaptations to functional overload of the plantaris in adult mice. J Appl Physiol (1985) 2016;120:188‐95.

12. Miyazaki D, Nakamura A, Fukushima K, Yoshida K, Takeda S, Ikeda S. Matrix metalloproteinase-2 ablation in dystrophin-deficient mdx muscles reduces angiogenesis resulting in impaired growth of regenerated muscle fibers. Hum Mol Genet 2011;20:1787‐99.

13. McMaster WC, Liddle S. Cryotherapy influence on posttraumatic limb edema. Clin Orthop Relat Res 1980;150:283‐7.

14. Rana M, Gellrich NC, von See C, Weiskopf C, Gerressen M, Ghassemi A, et al. 3D evaluation of postoperative swelling in treatment of bilateral mandibular fractures using 2 different cooling therapy methods: a randomized observer blind prospective study. J Cranio-Maxillofac Surg 2013;41:e17-23.

15. Schaubel HJ. The local use of ice after orthopedic procedures. Am J Surg 1946;72:711‐4.

16. Okoro T, Ibrahim Y, Mansour N, Alderman P, Evans A. The use of cryotherapy in the early postoperative period after total hip arthroplasty. Ortop Traumatol Rehabil 2019;21:339‐48.

17. Ni SH, Jiang WT, Guo L, Jin YH, Jiang TL, Zhao Y, et al. Cryotherapy on postoperative rehabilitation of joint arthroplasty. Knee Surg Sports Traumatol Arthrosc 2015;23:3354‐61.

18. Speer KP, Warren RF, Horowitz L. The efficacy of cryotherapy in the postoperative shoulder. J Shoulder Elbow Surg 1996;5:62‐8.

19. Millett PJ, Wilcox RB 3rd, O'Holleran JD, Warner JJP. Rehabilitation of the rotator cuff: an evaluation-based approach. J Am Acad Orthop Surg 2006;14:599‐609.

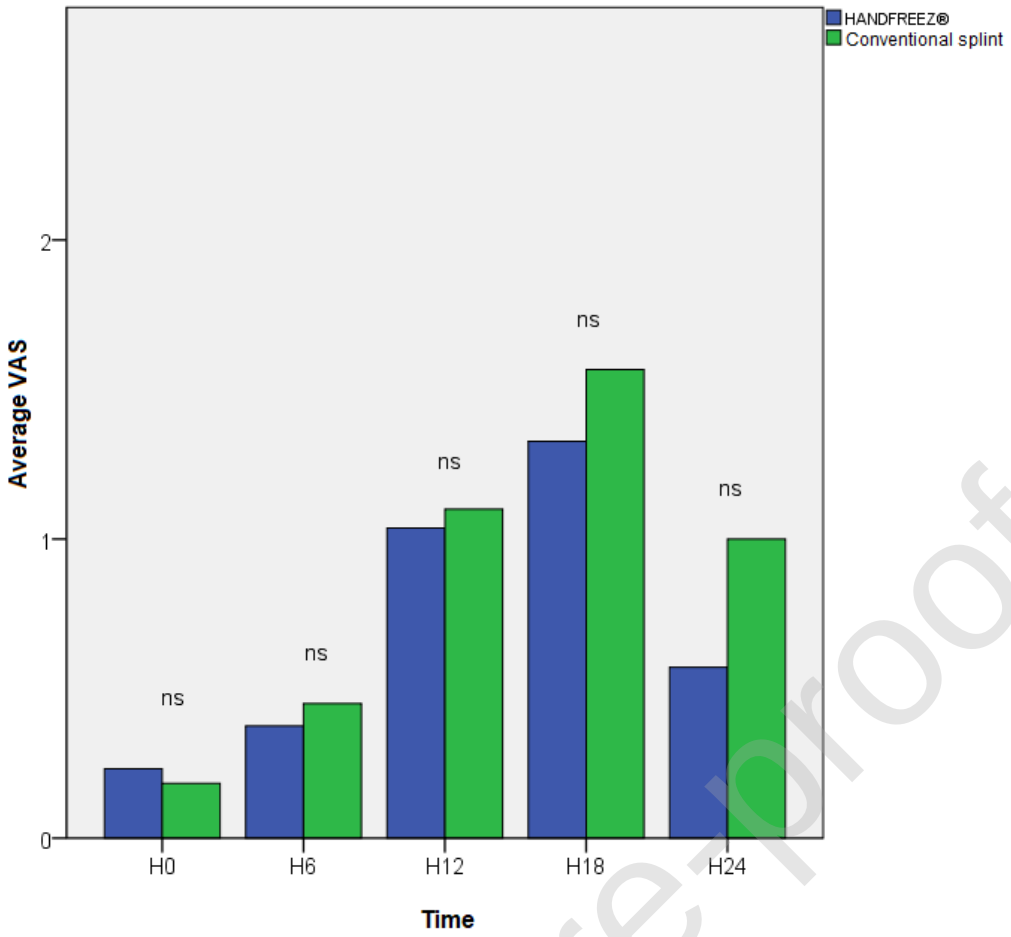
20. Flecke J, Vogt PM, Meyer-Marcotty MV. [The effects of standardised cold and compression therapy on swelling, pain and functional outcome after division of the transverse carpal ligament in carpal tunnel syndrome]. Handchir Mikrochir Plast Chir 2018;50:22‐30.

21. Meyer-Marcotty M, Jungling O, Vaske B, Vogt PM, Knobloch K. Standardized combined cryotherapy and compression using Cryo/Cuff after wrist arthroscopy. Knee Surg Sports Traumatol Arthrosc 2011;19:314‐9.

22. Bleakley CM, McDonough SM, MacAuley DC, Bjordal J. Cryotherapy for acute ankle sprains: a randomised controlled study of two different icing protocols. Br J Sports Med 2006;40:700‐5; discussion 705.

23. Knobloch K, Grasemann R, Spies M, Vogt PM. Midportion Achilles tendon microcirculation after intermittent combined cryotherapy and compression compared with cryotherapy alone: a randomized trial. Am J Sports Med 2008;36:2128‐38.

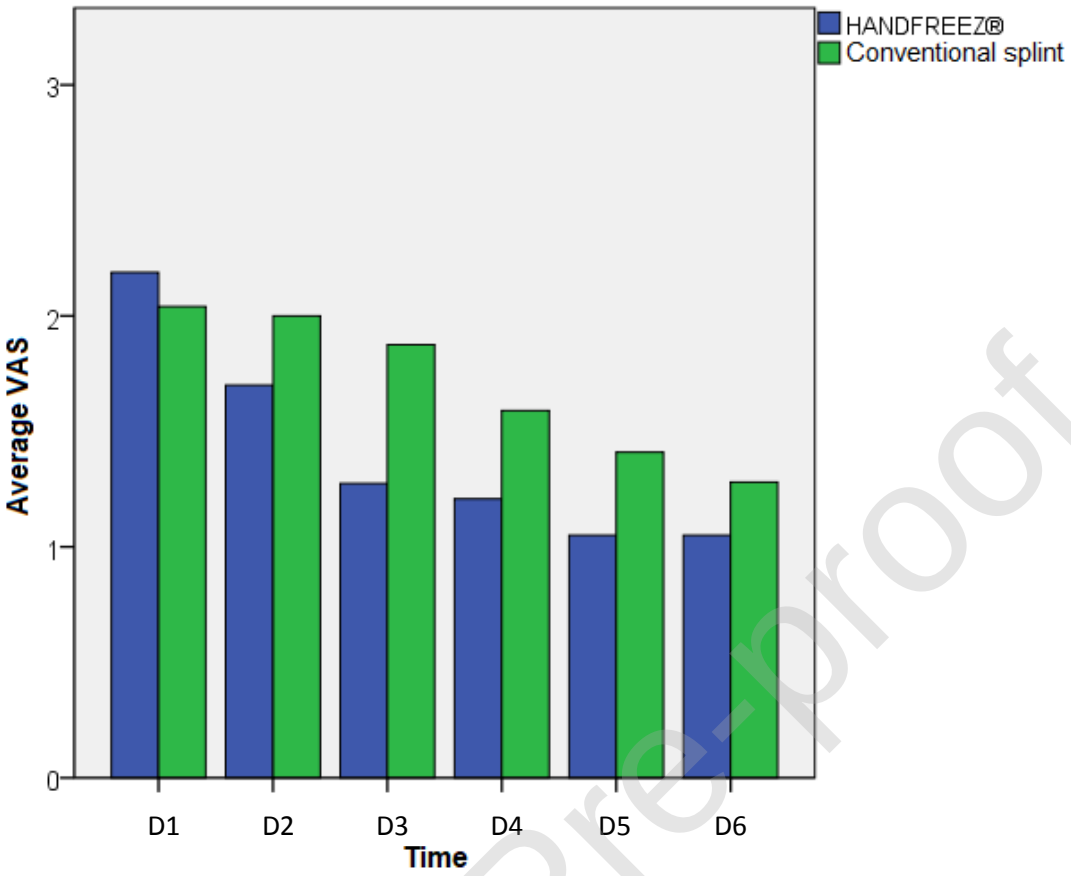
24. Khanna A, Gougoulias N, Maffulli N. Intermittent pneumatic compression in fracture and soft-tissue injuries healing. Br Med Bull 2008;88:147‐56.



ns: not significant

	VAS-Handfreez®	VAS-standard splint	P
H0	0.23 (0-3)	0.18 (0-5)	0.78
H6	0.38 (0-5)	0.45 (0-5)	0.78
H12	1.04 (0-7)	1.10 (0-8)	0.90
H18	1.33 (0-8)	1.57 (0-8)	0.63
H24	0.57 (0-6)	1.00 (0-7)	0.40

Fig. 1. Average pain level on a visual analog scale (VAS) during hospitalization



	VAS-Handfreez®	VAS-standard splint	P
D1	2.19 (0-8)	2.04 (0-7)	0.74
D2	1.70 (0-7)	2.00 (0-6)	0.44
D3	1.28 (0-7)	1.88 (0-7)	0.13
D4	1.21 (0-6)	1.59 (0-6)	0.31
D5	1.04 (0-6)	1.41 (0-7)	0.33
D6	1.05 (0-6)	1.28 (0-6)	0.51

Fig. 2. Average pain level on a visual analog scale (VAS) at home between D1 and D6

Table 1. Consumption of analgesics and NSAIDs during hospitalization (24 hours) expressed as the cumulative number of times certain drugs were taken by the patient

	Handfreez®	Standard splint	P
Paracetamol	1.70 (0-4)	2.17 (0-5)	0.08
Tramadol/Level 2	0.37 (0-5)	0.57 (0-3)	0.47
Morphine	0.00	0.13 (0-3)	0.04
NSAID	0.97 (0-2)	1.33 (0-3)	0.11

Table 2. Consumption of analgesics and NSAIDs at home (D1 to D6) expressed as the number of times certain drugs were taken by the patient

	Handfreez®	Standard splint	P
Paracetamol	6.13 (0-15)	6.92 (0-15)	0.49
Tramadol/Level 2	1.73 (0-27)	1.1 (0-11)	0.55
Morphine	0.00	0.00	–
NSAID	1.77 (0-7)	5.00 (0-18)	0.007