

## Original Article

## The Effect of Plantar Hyperkeratosis Debridement on Self-Perception of Pain Levels in older People

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## SUMMARY

**Background:** Plantar hyperkeratotic lesions are one of the most prevalent foot problems among older people. Because of its simplicity, the most common treatment is scalpel debridement. While some studies have analysed its effectiveness in the short term or among other population groups, none has analysed its effects in the medium term. The aim of this study is to assess the effectiveness of plantar hyperkeratosis debridement compared to a control group receiving sham debridement among an older population group.

**Methods:** Two hundred older participants (76.4 ± 4.8 years) were randomly assigned to two groups: scalpel debridement of plantar hyperkeratoses (experimental group) or sham debridement (control group). Plantar hyperkeratotic pain was measured on a visual analogue scale.

**Results:** The results suggest that there were no significant differences between the groups studied just after treatment ( $p = 0.27$ ), although significant differences between them were found as from 24 h after treatment ( $p = 0.05$ ) and 2 ( $p = 0.03$ ), 3 ( $p = 0.04$ ), 4 ( $p = 0.04$ ) and 5 days after treatment ( $p = 0.04$ ).

**Conclusions:** The results of this study suggest that there were significant differences in self-perception of pain levels between the group of older people treated for plantar hyperkeratoses with scalpel debridement and the control group as from 24 h after treatment.

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## 1. Introduction

Hyperkeratosis is defined as a thickening of the stratum corneum of the epidermis caused by hypertrophy or hyperplasia of its cells.<sup>1</sup> This increase fundamentally affects the keratinocytes or corneocytes, which are the most numerous cells of the outermost layer of the epidermis.<sup>2,3</sup>

Hyperkeratosis can be understood as a natural defence mechanism of the skin, which increases in thickness to compensate for pressure, friction or other irritants.<sup>4</sup> The physiological mechanism responsible for the development of a hyperkeratotic lesion is not fully understood, but it has been suggested that the production of hyperkeratoses may be stimulated by microtrauma in the tissues in the form of mechanical compression, which triggers the release of inflammatory and chemical mediators and of growth factors.<sup>5</sup> These chemical mediators are believed to be the main causes of

an increase in cell production, of transit time through the epidermis and of cohesion between cells. This then leads to a hyperkeratotic plaque caused by an increase in the stratum corneum, which has been defined as an excessive localised formation of keratin that acts as a foreign irritant.<sup>6</sup>

Plantar hyperkeratotic lesions are one of the most prevalent foot problems, affecting 30–65% of people aged over 65 years.<sup>7</sup> With age, the skin undergoes several changes that cause alterations in the functions of the integumentary system and the formation of hyperkeratosis.<sup>8,9</sup>

Hyperkeratoses are a common cause of foot pain<sup>10</sup> due to the release of inflammatory mediators and/or to the pressure of the keratin nucleus of corns on the underlying nerves,<sup>2</sup> which can have an impact on the mobility and independence of people suffering from them, thereby making their quality of life considerably worse.<sup>11</sup> Fig. 1.

The treatment of plantar hyperkeratoses accounts for 75% of a podiatrist's total workload in daily practice.<sup>6</sup> Several therapeutic options have been proposed for treating them: keratolytics,<sup>12</sup> moisturisers,<sup>13</sup> paddings,<sup>14</sup> orthotics,<sup>15</sup> footwear,<sup>16</sup> surgery,<sup>17</sup> and

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Fig. 1. Treatment of plantar hyperkeratoses with scalpel debridement.

patient education.<sup>18</sup> However, because of its simplicity, the treatment of choice is usually scalpel debridement of hyperkeratoses.<sup>19</sup>

Several studies have found significant differences between scalpel debridement and pain reduction using the visual analogue scale (VAS).<sup>20–22</sup> Surprisingly though, only two of the studies analysing the effectiveness of hyperkeratosis debridement had a control group.<sup>23,24</sup> No significant differences were found in either case between pain levels before and after treatment despite observing a reduction on the VAS in the two groups analysed (experimental and control). Nor did those studies analyse the effect of debridement on pain in the medium term.

The aim of this study is, therefore, to assess the effectiveness of plantar hyperkeratosis debridement on a group of older participants' self-perception of pain.

## 2. Material and methods

### 2.1. Subjects

To conduct this study, 200 participants ( $n = 200$ ) recruited in 2016 by the University of Barcelona's Podiatry Hospital (located in Barcelona, Spain) were analysed. To avoid bias in sample selection, every patient who had attended the Hospital's Chiropody Service was invited to take part in the study. The criteria for inclusion in this study were that participants had to be older than 65 years and presenting with painful plantar hyperkeratoses in the forefoot zone. Patients were excluded from the study if they had undergone any type of surgery on a lower limb in the past 18 months; were suffering from any ankle ailments, neurological, visual or vestibular system disorders or plantar verrucas; were unable to fill in questionnaires; had undergone hyperkeratosis debridement in the past six weeks (performed by a podiatrist or by themselves); had had any pathologies that cause hyperkeratosis (tinea pedis, eczema or psoriasis); were unable to walk household distances without help or were amputees. None of the participants received any payment in cash or in kind for taking part in the study, and all of them signed an informed consent form. This study was approved by the Institutional Review Board (1R800003099) of the Ethics Committee of the University of

Barcelona (Barcelona, Spain). All of the participants were given a copy of the informed consent form.

### 2.2. Protocol

For this randomised controlled trial and prior to treatment, all of the participants signed an informed consent form, completed a health history form and filled in a questionnaire to collect their anthropometric data (age, gender, height and weight). They were randomly divided into two groups (A and B). Group A was the experimental group and Group B was the control group. Participant randomisation was done by simple random assignment using a balanced table of random numbers.<sup>25</sup> The groups to which participants would be assigned were contained in opaque sealed envelopes. An independent observer issued these in a sequential manner. This method has been used previously<sup>26</sup> and is recommended by the CONSORT Statement.<sup>27</sup> No significant differences were found between the two study groups. The treatment given to each group was:

- Group A: Full scalpel debridement of all plantar hyperkeratoses down to the underlying pink skin.
- Group B: Control group. Hyperkeratosis debridement was simulated using the blunt edge of a scalpel so there was no actual debridement (sham debridement).

Rubbing alcohol was used to disinfect the skin of every participant's feet before and after treatment, and a plastic screen was positioned to prevent participants from seeing the treatment they were receiving. After treatment, a piece of self-adhesive dressing (Mefix) was applied to both feet of every participant to prevent them from seeing the soles of their feet. This was changed every 24 h and removed after five days. The duration of the treatment was controlled to ensure that it was no longer than 20 min.

Furthermore, any participant who was injured during the debridement process was excluded from the study because it was felt that this might alter the participant's perception of pain.<sup>28</sup> The participant's level of satisfaction was assessed independently for each foot using a VAS.

Pain levels were assessed, as an average of all hyperkeratotic lesions, after the participant had walked 5 m along a corridor, both before and just after treatment, and then every 24 h. The assessment of the relationship between pain intensity and the quantity of plantar hyperkeratoses was represented on a 100 mm line, where 0 indicated no pain and 100 indicated maximum pain. The VAS is quick to administer, has proven validity and reliability<sup>29</sup> and has been used to measure participants' pain reduction during podiatric treatment.<sup>30</sup> The protocol flow diagram is shown in Fig. 2.

### 2.3. Statistical analysis

Standard descriptors were used to describe the data, and non-parametric methods were used for all the inferential statistical analyses due to the type and distribution of pain scale data. The data were analysed using Friedman's test for repeated measures. All the calculations were done using SPSS software (version 20.0). Differences were considered statistically significant when they reached values of  $p < 0.05$ .

### 3. Results

In our study, the participants' mean age was 76.4 years ( $SD \pm 4.8$  years) and the mean VAS pain level was 63.9 mm ( $SD \pm 22.7$  mm). The majority of the participants were women (62% of the sample). The study sample characteristics are shown in Table 1.

The results of this study suggest that debridement and sham debridement of plantar hyperkeratoses of the forefoot did not affect self-perception of pain levels just after treatment ( $p = 0.27$ ), though it did have a significant influence 24 h after treatment ( $p = 0.05$ ), and 2 ( $p = 0.03$ ), 3 ( $p = 0.04$ ), 4 ( $p = 0.04$ ) and 5 days after treatment ( $p = 0.04$ ). All of the results are shown in Table 2 and in Fig. 3.

### 4. Discussion

To our knowledge, this is the first study to analyse and compare, over a period longer than two days, self-perception of pain levels between those participants who had undergone plantar hyperkeratosis debridement and those who had received sham debridement (control group). At the time of writing, to our knowledge there were only two studies analysing the effectiveness of plantar hyperkeratosis debridement on self-perception of pain that had used a control group (sham debridement). Davys et al.<sup>20</sup> analysed the effect of hyperkeratosis debridement among a population group suffering from rheumatoid arthritis ( $n = 34$ ), so the results thereof could not be extrapolated to other population groups. Furthermore, the placebo effect was only present in the short term, i.e., until just after treatment, and the participants' self-perception of pain was not assessed subsequently. In a similar study to ours, Landorf et al.<sup>24</sup> analysed the effect of debridement in a group of older people ( $n = 80$ ). After treatment or sham treatment, a piece of self-adhesive dressing (Mefix) was applied in order to protect the treated area

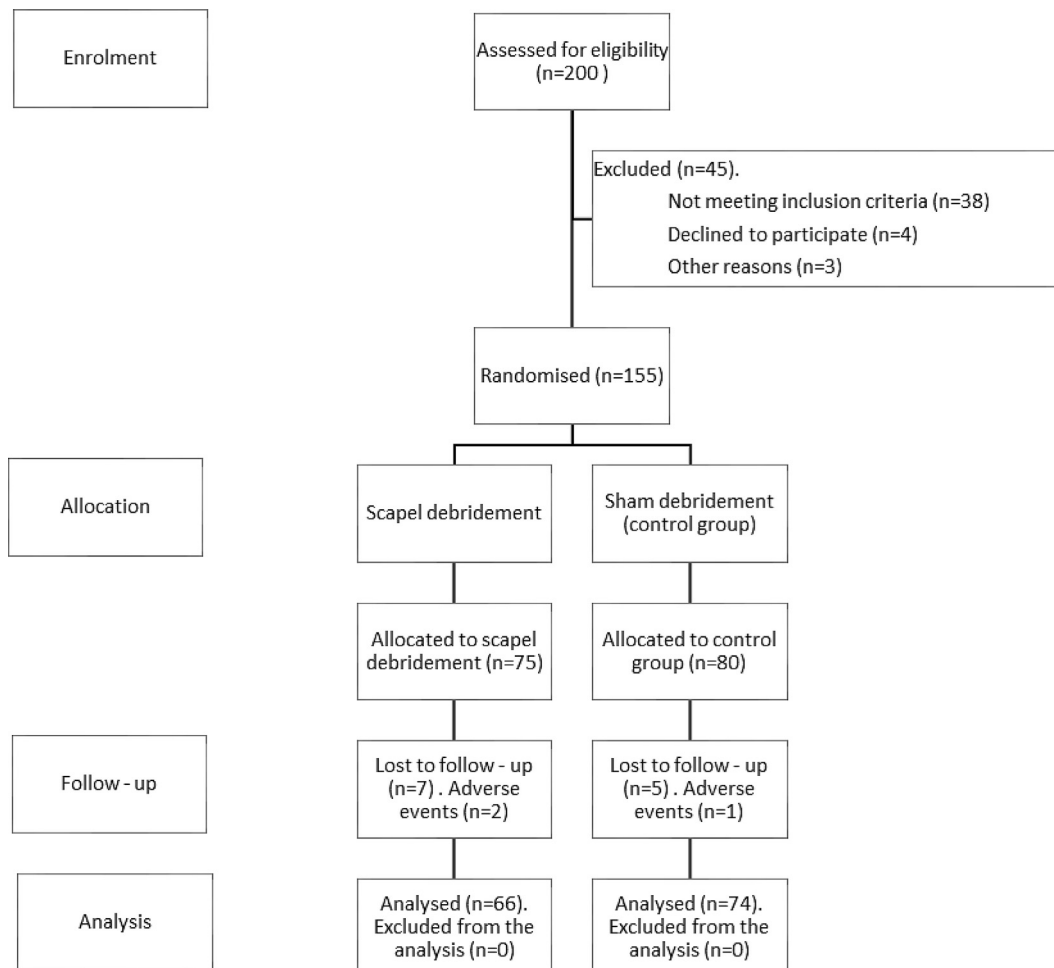


Fig. 2. Participant flow diagram.

**Table 1**  
Study sample characteristics. SD: Standard deviation.

	Scalpel debridement (n = 75)	Sham debridement (n = 80)	Total (n = 155)
n = (155)	Mean (SD)	Mean (SD)	Mean (SD)
Age	75.2 (4.5)	76.9 (5.2)	76.4 (4.8)
Height (m)	1.64 (0.22)	1.65 (0.15)	1.63 (0.20)
Weight (kg)	73.4 (12.7)	72.8 (11.2)	73.4 (11.9)
Body mass index (kg/m <sup>2</sup> )	27.5 (4.9)	28.3 (5.1)	27.9 (5.0)
Obesity BMI >30 (%)	16	17	16.7
Men (%)	37	39	38
Women (%)	64	61	62
VAS HK Pain (0–100)	62.8 (22.4)	64.2 (23.2)	63.9 (22.7)

**Table 2**  
Pain assessment using the visual analogue scale (VAS). Mean ± (Standard Deviation).

	Scalpel debridement (n = 75)	Sham debridement (n = 80)	p
n = (155)	Mean (SD)	Mean (SD)	
Baseline	62.8 (22.4)	64.2 (23.2)	0.53
Just after treatment	17.2 (14.5)	35.2 (20.3)	0.27
1 day after treatment	16.5 (13.5)	53.7 (22.7)	0.05
2 days after treatment	16.8 (15.2)	59.6 (23.2)	0.03
3 days after treatment	18.5 (16.3)	56.3 (28.6)	0.04
4 days after treatment	17.1 (17.6)	60.8 (28.5)	0.04
5 days after treatment	18.3 (16.2)	59.8 (26.3)	0.04

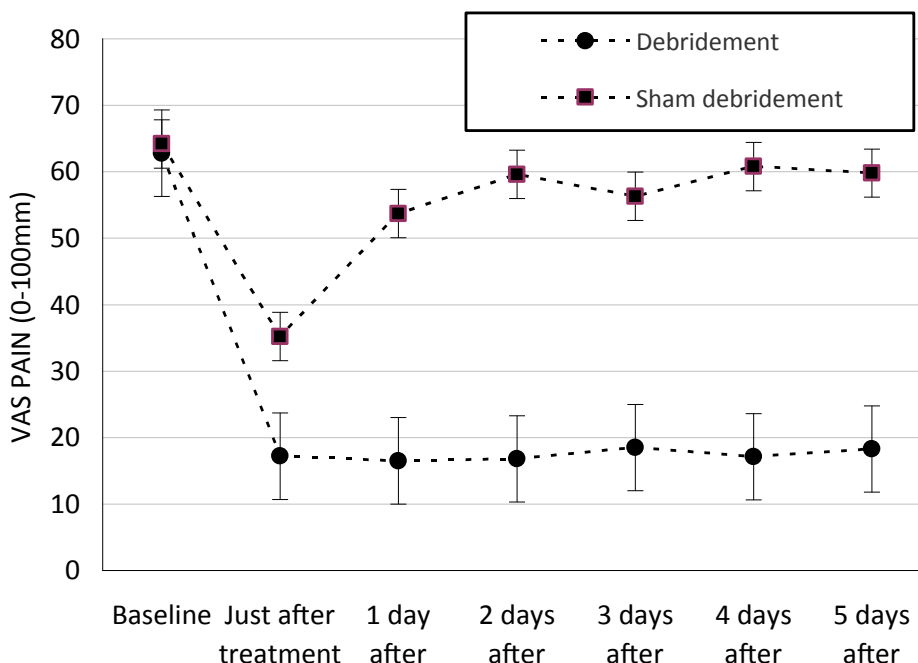
(experimental group) or to prevent participants from seeing the area that had supposedly been treated (control group). Unlike in our study, the piece of self-adhesive dressing was replaced after post-treatment assessment by a Moleskin dressing, while the sham treatment dressing was kept for at least two days and no additional information was provided at the time of its removal. Moleskin dressings are made from heavy cotton fabric with adhesive strips. When applied to the foot or feet, they can alter self-perception of pain levels by reducing pressure on the area.<sup>31</sup>

Neither of the two studies found any significant differences in self-perception of pain levels before and after treatment despite

observing a reduction on the VAS in the two groups analysed (experimental and control). According to the researchers who conducted those studies, this might have been due to the Hawthorne effect. This effect is a type of psychological reactivity in which the subjects of an experiment modify certain aspects of their behaviour in response to their awareness of being observed and not in response to any type of manipulation considered in the experimental study.<sup>32</sup>

In our study, as was the case in previous studies, no significant differences were found in self-perception of pain levels just after treatment (p = 0.27). These results differ from those reported in other studies conducted without a control group (sham treatment), where there was a significant reduction in pain ranging from 35 mm to 60 mm on the VAS (p < 0.001) between pre- and post-debridement of hyperkeratoses.<sup>20–22</sup> However, we did find significant differences 24 h after treatment (p = 0.05) and 2 (p = 0.03), 3 (p = 0.04), 4 (p = 0.04) and 5 days after treatment (p = 0.04) in the experimental group.

The lack of significant differences found between the two groups just after treatment may have been due to a number of reasons. Firstly, the sham debridement in the control group was done using the blunt edge of a scalpel so as to make the participants believe they were being treated. The results obtained may therefore have been due to the Hawthorne effect, the patient improves only because they know that they are supposedly treated, although this is not the case. This fact would condition that the subject improve at the beginning, but as the days go by, the pain itself would cause it to deduce that it has been used as a control subject. Secondly, those results may have been due to the fact that the participants were only made to walk a short distance (5 m) to assess their self-perception of pain levels. Since there is no protocol that makes recommendations about the total amount of time a participant ought to walk before assessing pain levels, future studies should be conducted with the intention of elucidating the distance from which the presence of pain could be made objective. In addition, these distances might differ depending on the type of population analysed. For example, given that our study was conducted on older people, it may be the case that they require more time to walk in



**Fig. 3.** Pain assessment using the visual analogue scale (VAS). Mean ± (Standard Deviation).



order to be able to properly discern plantar hyperkeratoses because of the potential alterations in sensitivity among this population.<sup>33</sup>

This tendency in the results changed as from 24 h after treatment, when significant differences were found and the effectiveness of plantar hyperkeratosis debridement was confirmed. The immediate relief of pain is associated with hyperkeratosis removal<sup>20</sup> because it has been found that an excessive localised formation of keratin acts as a physical foreign irritant that increases pressure in the area.<sup>2</sup>

Despite the wide range of methods available for hyperkeratosis treatment, the treatment of choice is usually scalpel debridement because of its simplicity and effectiveness.<sup>34</sup> This type of treatment is simple and effective for reducing plantar pressure and pain,<sup>35</sup> and it does not depend on a participant's compliance with the use of accessories.<sup>24</sup> In addition, proper treatment of plantar hyperkeratoses will improve older people's mobility and independence since earlier studies have shown that hyperkeratoses make balance and functional capacity worse, thereby increasing the risk of falls.<sup>36</sup> Early diagnosis and treatment can also prevent the skin from breaking due to the high plantar pressures generated, since plantar hyperkeratoses often precede the onset of ulceration of the foot.<sup>37</sup>

A number of limitations of this study should be noted. Firstly, this study was conducted on an older population sample. This should be taken into account when considering intensities of perceived pain, especially since the perception of pain may change with age.<sup>38</sup> Future studies in which the potential existence of an alteration in the degree of pain perception is assessed in advance are required in order to get a more in-depth knowledge of the real effect of this treatment in a normal population. It should also be noted that the laterality of the subject was not considered when it came to performing the treatment. Various authors have suggested the possible existence of differences in self-perception of pain levels depending on the laterality of the participant.<sup>39</sup> Although some of these studies were conducted on an upper limb, they suggest that pain may be perceived differently in each of the brain hemispheres, thereby altering self-perception of pain levels depending on which limb is assessed. In addition, the dominant limb seems to have a faster and more precise reaction to pain than its contralateral counterpart.<sup>38</sup>

## 5. Conclusions

The results of this study suggest that there were significant differences between older participants' self-perception of pain levels before and after plantar hyperkeratosis debridement as from 24 h after treatment and for each of the 5 days after treatment. Plantar hyperkeratosis debridement appears to be a useful treatment for reducing pain sensitivity. Future studies in which perception of pain levels are assessed over a period longer than five days are required.

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