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ORIGINAL ARTICLE

Infrared sauna in patients with rheumatoid arthritis and ankylosing spondylitis

A pilot study showing good tolerance, short-term improvement of pain and stiffness, and a trend towards long-term beneficial effects

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Abstract To study the effects of infrared (IR) Sauna, a form of total-body hyperthermia in patients with rheumatoid arthritis (RA) and ankylosing spondylitis (AS) patients were treated for a 4-week period with a series of eight IR treatments. Seventeen RA patients and 17 AS patients were studied. IR was well tolerated, and no adverse effects were reported, no exacerbation of disease. Pain and stiffness decreased clinically, and improvements were statistically significant ($p<0.05$ and $p<0.001$ in RA and AS patients, respectively) during an IR session. Fatigue also decreased. Both RA and AS patients felt comfortable on average during and especially after treatment. In the RA and AS patients, pain, stiffness, and fatigue also showed clinical improvements during the 4-week treatment period, but these did not reach statistical significance. No relevant changes in disease activity scores were found, indicating no exacerbation of disease activity. In conclusion, infrared treatment has statistically significant short-term beneficial effects and clinically relevant period effects during treatment in RA and AS patients without enhancing disease activity. IR has good tolerability and no adverse effects.

Keywords Ankylosing spondylitis · Hyperthermia · Inflammation · Infrared sauna · Physical therapy modalities · Rheumatoid arthritis

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Introduction

Since Hippocratic times, heat treatment has been popular among people with rheumatic disorders. The evidence for their application is still weak, despite the fact that several studies investigating the effects of heat in rheumatic diseases have been conducted [1, 2]. Superficial heat can be used in rheumatoid arthritis and low back pain as a palliative therapy and can be recommended for beneficial short-term effects, but these recommendations are limited by methodological considerations such as the poor quality of trials [3, 4].

Finnish saunas, a well-known form of total-body heating, showed good clinical effects for rheumatic patients [5, 6].

The so-called whole-body hyperthermia has also been widely used during the last century, especially in Germany and Eastern European countries and was known as “fever treatment” [7]. Although beneficial effects of total-body hyperthermia have been reported [8, 9], controlled studies have not been performed, and the method is not often used in Western Europe.

During the past 10 years, a new modality for whole-body hyperthermia, named infrared (IR) sauna, has become

available in the Europe. It is a compact and user-friendly IR "whole-body hyperthermia." Personal experiences of rheumatoid arthritis (RA) and ankylosing spondylitis (AS) patients in our out-patients clinic appeared to be promising. They experienced less pain and improved physical functioning. Despite the theoretical possibility of negative effects on disease activity, in our clinical series, no aggravation of inflammation activity was seen.

The new IR cabin differs from the traditional Scandinavian saunas. The heating effect of a high ambient temperature is comparable, but due to the addition of infrared radiation, some heat penetrates maximally up to 4 mm into the superficial skin [10]. As this might result in different physiological responses compared to the Finnish sauna, we first studied the physiological effects of infrared whole-body treatment in healthy subjects before starting clinical trials in rheumatic patients [11]. Fifteen healthy subjects were exposed to total-body heat treatment in an infrared cabin at three different intensities (40°C, 55°C, and 70°C). Mean skin surface temperature (2.6°C, 6.8, and 9.1°C, respectively), core temperature (0.4°C, 0.5°C, and 0.6°C, respectively), and heart rate (+14, +37, and +58 beats per minute, respectively) increased significantly. Significant loss of bodyweight after treatment was also found (0.1, 0.3, and 0.4 kg, respectively). In general, a small decrease of systolic and diastolic blood pressure was shown.

The purpose of this study was to determine whether these previously found physiological changes would also provide beneficial effects in patients with rheumatic disorders. The more explicit research questions, therefore, are:

1. What is the effect of IR sauna on body functions and structures, such as pain, stiffness, and fatigue (primary outcomes)?
2. What is the effect of IR on physical activities and (social) participation (secondary outcomes)?
3. Are there any side effects regarding comfort and tolerance during treatment and disease activity (tertiary outcomes)?

Patients and methods

Inclusion criteria People with RA according to the revised American Rheumatism Association [12] or with AS according to the New York [13] criteria between 18 and 70 years of age and only patients with chronic disease that had been stable for at least 3 months without change in medication were included.

Exclusion criteria Patients with a change of treatment during 3 months prior to the start of the study; patients with signs of acute inflammatory activity (morning stiffness lasting longer than 1 h or more than three joints actively inflamed) as judged by the consulting rheumatologist (heat treatment may aggravate clinical signs and inflammatory activity in an acute phase of the disease); patients permanently wheelchair-bound or bedridden; patients with the following comorbidities: heart disease, skin disease, malignancy, asthmatic bronchitis, or psychiatric disorders are excluded.

Patients were recruited consecutively from the rheumatology out-patients clinic (JJR) in a general district hospital in Enschede, The Netherlands.

After oral and written information about the study and the possible clinical effects of IR whole-body hyperthermia, patients were invited to participate. Informed consent was obtained from all patients, according to the Declaration of Helsinki.

Treatment The patients were treated in the Health Company Infrared Cabin (kindly made available by The Health Company, P.O. Box 321, 2400 AH Alphen a/d Rijn, the Netherlands), which was 130×90×190 cm in size. The temperature in the cabin can be adjusted from normal ambient room temperature up to 90°C. The patients were seated in the infrared cabin, which has six heating sources; three at the back, two in front besides the entrance, and one under the bench behind the lower legs of the patients. The infrared used has a long wavelength between 5,000 and 1,000,000 nm.

The patients were treated for a period of 4 weeks, twice weekly, with eight IR sessions in the IR cabin (30 min at an ambient temperature of 55°C). According to the manufacturers' recommendation, before treatment, a preheating time of the IR whole-body hyperthermia equipment of 15 min was used. During the whole study period, the dosages of nonsteroidal anti-inflammatory drugs and disease-modifying antirheumatic drugs were not changed; treatments with physiotherapy, when applied, were not changed, and no corticosteroid injection was given

Measurements Clinical measurements were performed 4 weeks before the start, at the start, and at the end of the 4-week period of IR treatments and 4 weeks after the end of the treatment series; all four assessments were at the same time of the day and executed by a trained physiotherapist unaware of the study protocol. The pretreatment period without IR sauna was meant as a control and the 4 weeks after treatment as follow-up.

The patient's perceptions of pain [14], stiffness [15], and fatigue [16–18] were measured on a 100-mm visual analog scale and were considered as primary outcomes.

Secondary outcomes for the RA patients were: Escola Paulista de Medicina Range of Motion (EPM-ROM scale)

[19] and activities and participation scales of the Dutch Arthritis Impact Measurement Scales (DUTCH-AIMS) [20]. For AS patients, Bath Ankylosing Spondylitis Global Score [21], the Bath Ankylosing Spondylitis Metrology Index (BASMI, a ROM-index) [22], and the Bath Ankylosing Spondylitis Functional Index [23] were used. To evaluate possible effects on the disease activity (improvement or exacerbation) for RA patients, the Disease Activity Score using 28 joints (DAS 28) [24] was calculated, and for AS patients, the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) [25] and the erythrocyte sedimentation rate (ESR) after 1 h were assessed. The DAS 28, BASDAI, and ESR were considered as tertiary outcomes. These measurements are fairly routine in clinical research and have been proven to be valid, reliable, and of good sensitivity to change [14–25].

Short-term effects Directly before and after the first IR treatment, the primary outcomes were registered to measure the immediate effect of IR on pain, stiffness, and fatigue. Besides that, during and after the first treatment, well-being (as tertiary outcome) was recorded on a five-point Likert scale (very uncomfortable, uncomfortable, neutral, comfortable, and very comfortable). Well-being was measured at 15 and 30 min after the start of the treatment (patient still in the cabin) and 30 min after the end of treatment (patient out of cabin).

Statistics The continuous data were checked for normality. This was done with the descriptive statistics explore command in Social Package for Social Sciences (SPSS) 14.0 [26] by making histograms, scatter graphs, normality plots, normal curves, and carrying out normality tests (Kolmogorov–Smirnov and Shapiro–Wilk). Continuous data were statistically analyzed by means of repeated measure analysis with Bonferroni correction within SPSS 14.0. Results are expressed as mean and SEM (Standard Error of Mean). For nonparametric data (well-being on an ordinal Likert scale), Wilcoxon signed-rank test for related samples was applied. Level of significance (α) was chosen at 0.05.

Ethics The ethical committee of the Hospital Medisch Spectrum Twente, Enschede, The Netherlands approved the study design.

Table 1 Patient characteristics

	RA patients	AS patients
Gender	3 male, 15 female	13 male, 5 female
Age	47 SD 13 (26–70)	44 SD 10 (23–57)
Disease duration	13 SD 10 (3–29)	21 SD 10 (4–40)

Mean in years, SD (minimum–maximum)
RA Rheumatoid arthritis, *AS* ankylosing spondylitis

Table 2 Steinbröcker classification of rheumatoid arthritis patients (n=17)

Stage	Number of patients
I	2
II	8
III	6
IV	1

Results

Patient characteristics Of 37 patients approached, one declined (could not participate due to nonmedical reasons) and 36 were enrolled into the study. A total of 18 patients with rheumatoid arthritis and 18 patients with ankylosing spondylitis entered the study with mean age of 47 and 44 years, respectively (Table 1).

One RA and one AS patient dropped out in the pretreatment period due to exacerbation of RA and acute lumbar nerve root compression, respectively, and could not be measured for follow-up. Therefore, the mean group results of 17 RA and 17 AS patients are presented. Functional capacity of RA patients according to Steinbröcker classification [27] is shown in Table 2.

Immediate effects of IR whole-body hyperthermia Pain and stiffness significantly decreased clinically ($p<0.05$ and $p<0.001$ in RA and AS patients, respectively) during an IR session (Table 3). Fatigue also improved, but this did not reach statistical significance.

Delayed effects during and 4 weeks after treatment on primary outcomes In RA patients, pain, stiffness, and fatigue showed slight improvements during the 4-week treatment period; stiffness almost reached statistical significance: $p=0.06$ (Table 4). In the AS patients, stiffness improved after the treatment, but this did not reach statistical significance ($p=0.30$); otherwise, small or no effect were seen during the treatment and post-treatment periods (Table 4).

Table 3 Immediate effects of IR sauna treatment

	Pain		Stiffness		Fatigue	
	Before	After	Before	After	Before	After
RA	25 (5)	15 (5)*	25 (5)	12 (3)*	35 (7)	30 (7)
AS	26 (4)	11 (3)**	40 (6)	16 (4)**	37 (6)	28 (6)

VAS, 0–100 mm; mean (SEM)
IR infrared, *RA* rheumatoid arthritis, *AS* ankylosing spondylitis
*$p<0.05$, **$p<0.001$

Table 4 Outcome primary effect variables 4 weeks before IR sauna, at start and end of the 4-week treatment period and 4 weeks after treatment

	Pretreatment	Start treatment	End of treatment	Post-treatment
RA patients				
Pain	30 (5)	29 (6)	24 (5)	27 (4)
Stiffness	28 (6)	27 (5)	17 (5)*	23 (5)
Fatigue	37 (6)	36 (6)	33 (6)	39 (7)
AS patients				
Pain	26 (6)	26 (4)	30 (5)	27 (6)
Stiffness	40 (7)	38 (6)	32 (7)	31 (7)
Fatigue	34 (7)	37 (7)	35 (7)	30 (7)

VAS, 0–100 mm; mean (SEM)
IR Infrared, *RA* rheumatoid arthritis, *AS* ankylosing spondylitis
*$p=0.06$

Delayed effects during and 4 weeks after treatment on secondary outcomes Over the 12-week study period, no statistically significant change was found on secondary clinical and functional variables, such as ROM and DUTCH-AIMS for RA patients (Table 5) and Bath Ankylosing Spondylitis scores for AS patients (Table 5). However, there is a clear clinical improvement of RA patients on the physical, affective, and symptom scales of the DUTCH-AIMS. The effect persisted during the post-treatment phase on the physical and affective scales.

Well-being during and after treatment (tertiary outcomes) The RA patients felt comfortable during and after the treatment session. Especially after treatment, 59% felt comfortable and many felt even very comfortable (29.4%; Table 6). There was no statistically significant difference in well-being as measured at the three instances. The AS patients felt less comfortable during the treatment but after half an hour, almost all of them felt (very) comfortable (Table 6). The perceived well-being 30 min after treatment in AS patients showed better statistically significance compared to the other two measurement points ($p<0.01$).

Influence on disease activity No relevant change in disease activity measurements as reflected by DAS 28 in RA patients and BASDAI and ESR in AS patients was found, indicating no unwanted exacerbation of disease during or after IR treatment, and no other side effect was reported (for example fainting and headache; Table 5).

Discussion

In all patients, a clinically relevant improvement was seen during the IR sauna treatment with pain and stiffness decreasing 5 to 24 points on the VAS. Pain reduced approximately 40% and 60% and stiffness approximately 50% and 60% for patients with RA and AS, respectively (Table 3). All patients felt well during and after IR treatment, and 30 min after the end of treatment, 88.2% of patients felt “comfortable” or “very comfortable” (Table 6).

In RA patients, a clinically relevant improvement is seen during the 4-week treatment period compared to the

Table 5 Outcome secondary and tertiary effect variables 4 weeks before IR sauna, at start, and end of the 4-week treatment period and 4 weeks after treatment

	Pretreatment	Start treatment	End of treatment	Post-treatment
RA patients				
EPM-ROM	6.2 (0.6)	5.6 (0.6)	5.8 (0.7)	5.6 (0.6)
AIMS physical	2.3 (0.4)	2.6 (0.6)	1.6 (0.4)	1.7 (0.4)
AIMS affective	2.9 (0.3)	3.1 (0.5)	2.2 (0.3)	2.3 (0.4)
AIMS symptoms	4.0 (0.5)	4.0 (0.5)	3.3 (0.5)	3.9 (0.5)
AIMS social	4.3 (0.4)	3.8 (0.4)	3.7 (0.4)	4.2 (0.5)
DAS 28	3.96 (0.30)	3.74 (0.34)	3.58 (0.31)	3.63 (0.32)
AS patients				
BASGS (last week)	3.4 (0.7)	3.1 (0.7)	2.9 (0.7)	3.2 (0.8)
BASGS (26 weeks)	3.9 (0.7)	3.5 (0.7)	3.7 (0.8)	4.1 (0.8)
BASMI	2.0 (0.5)	2.4 (0.5)	2.2 (0.5)	2.3 (0.5)
BASFI	3.3 (0.6)	3.2 (0.6)	3.2 (0.6)	3.1 (0.6)
BASDAI	3.4 (0.5)	3.4 (0.6)	3.4 (0.6)	3.2 (0.6)
ESR	17 (3)	16 (4)	14 (2)	15 (3)

Mean (Standard error of the mean); low scores are better scores
IR Infrared, *RA* rheumatoid arthritis, *AS* ankylosing spondylitis, *EPM-ROM* Escola Paulista de Medicina Range of Motion score, *AIMS* Arthritis Impact Measurement Scales, *DAS 28* Disease Activity Score, *BASG* Bath Ankylosing Spondylitis Global Score, *BASMI* Bath Ankylosing Spondylitis Metrology Index, *BASFI* Bath Ankylosing Spondylitis Functional Index, *BASDAI* Bath Ankylosing Spondylitis Disease Activity Index, *ESR* erythrocyte sedimentation rate

Table 6 Well-being during and after IR sauna

	After 15 min		After 30 min		30 min after treatment	
	Number[a]	Percentage	Number[a]	Percentage	Number[a]	Percentage
RA patients						
1	0	0	2	11.8	0	0
2	2	11.8	2	11.8	0	0
3	3	17.6	2	11.8	2	11.8
4	10	58.8	9	52.9	10	58.8
5	2	11.8	2	11.8	5	29.4
AS patients						
1	0	0	3	17.6	0	0
2	4	23.5	3	17.6	1	5.9
3	2	11.8	3	17.6	1	5.9
4	9	52.9	2	11.8	9	52.9
5	2	11.8	6	35.3	6	35.3

IR Infrared, *RA* rheumatoid arthritis, *AS* ankylosing spondylitis
[a] Number of patients; 1 = very uncomfortable, 2 = uncomfortable, 3 = neutral, 4 = comfortable, 5 = very comfortable

pretreatment period, regarding pain and stiffness diminishing 5–10 points on the VAS, while during the previous nontreatment period, there was no noticeable change (Table 4). During the post-treatment period, these effects were lost. These effects are less obvious in AS patients (Table 4).

In RA patients, the physical, affective, and symptoms scales of the DUTCH-AIMS showed a trend of improvement during treatment, persisting during the post-treatment phase on the physical and affective scale (Table 5). It is not surprising that no relevant change was seen on the social scale because it cannot be expected that this period would have any influence on the relationship of a patient with family, friends, and relatives as measured on the social scale.

In the AS patients group, there are no changes on BAS global scores and functional index over time (Table 5). Apparently, IR whole-body hyperthermia does not have major effects on these domains.

No relevant change on EPM-ROM and BASMI in RA and AS patients, respectively, were found, so IR treatment does not seem to have any direct effect on the overall range of motion (Table 5). Probably, the impaired ROM in non-acutely inflamed joints, as was the case in our series, is mainly due to irreversible change in these joints, such as erosions and cartilage damage in RA patients and calcification of joint ligaments or bony outgrowth in AS patients. Therefore, no major improvement could have been expected without adequate additional exercises.

The effect of IR whole-body hyperthermia upon local joint inflammation or disease activity is not clear. The findings of earlier studies were controversial [9, 28–33], and many studies have poor or no optimal quality as summarized in the COCHRANE study [3]. For that reason, we have monitored disease activity as reflected by DAS 28 in RA patients and BASDAI and ESR in AS patients. No relevant change in these disease activity measurements was found, indicating no unwanted side effects of IR treatment (Table 5). This does not exclude that some individual cases may experience increased complaints during or after treatment.

From this study, it appears that IR whole-body hyperthermia has direct beneficial effects. Although in the long-term, there is a tendency toward improvement of clinical symptoms of RA and AS patients, there is no sufficient evidence that the short-term effect will last for several days or weeks. Therefore, further controlled clinical studies with a larger study population are necessary.

Because this was the first study of IR sauna, we had no idea about the mean group effect in RA or AS patients. Comparing the changes on primary outcome variables during treatment with those during the previous nontreatment period, we found an improvement of approximately 10% to 15%. So, from power calculations with 80% power and α of 0.05 for following controlled clinical studies, at least 25 patients per group are required. Furthermore, it is recommended to conduct comparable studies in patients with other types of musculoskeletal disorders such as osteoarthritis, osteoporosis, and fibromyalgia.

The results of this study show that the use of IR sauna as treatment is feasible and well tolerated in patients with inflammatory arthritis.

We would recommend that patients should first experience a couple of trial sessions to see whether they achieve any clinical benefit prior to commencing a course of IR. Based on that experience, continuation of treatment and the appropriate dose and application can be discussed with the physician or physiotherapist. Despite the evidence from this

study for positive short-term results and a trend towards beneficial clinical long-term effects, further controlled clinical studies are warranted.

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Conflict of interest statement None.

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