

A comparative study on the effect of water filtered infrared-A irradiation and common infrared irradiation in the treatment of lumbar disc herniation

MA Wei-ping¹, ZHU Bing², WANG Wen¹, KANG Ning-chao¹, MA Jun-ping¹, SUN Jin-zi¹, SHAN Su-ying¹ (1. Department of Minimally Invasive Spine Surgery, Zhongguancun Hospital, Beijing 100190, China; 2. Department of Orthopedics, PLA Army General Hospital, Beijing 100700, China)

Abstract: Objective To compare the pain and functional improvement in patients with lumbar disc herniation treated by Water filtered infrared-A and common infrared. **Method** 100 patients with lumbar disc herniation were treated with conservative treatment in our hospital from 2014 to 2016. They were randomly divided into two groups: water filtered infrared -A and common infrared. Before and after treatment using visual pain scale (VAS), SF-36 questionnaire and universal protractor on pain and quality of life, activity of lumbar spine (flexion and extension), straight leg raising test was assessed and analyzed. **Result** The difference of VAS and SF-36 before and after the treatment of water filtered infrared -A group was 4.13 ± 1.47 , 203 ± 126 , respectively, and the difference between the common infrared group was significantly higher than the 2.38 ± 1.71 , 116 ± 103 . The difference of water filtered infrared -A group was significantly different from that of common infrared group. Lumbar activity and straight leg raising test, before and after the treatment, the water filter infrared -A group of lumbar flexion and straight leg raising test treatment had significant difference compared with the common infrared. **Conclusion** The treatment of lumbar disc herniation with water filtered infrared-A radiation can better alleviate the pain and improve the quality of life than with common infrared.

Keywords: Infrared; Lumbar disc herniation; Pain; Function

(App-ÜBERSETZUNG AUS DEM CHINESISCHEN) Lumbar disc herniation is a common orthopedic disease, and it is also one of the common causes of low back pain. But in recent years, due to changes in the working environment and lifestyle, the incidence of lumbar disc herniation has gradually increased, and it is showing a younger trend. According to reports, only 10% to 15% of patients with lumbar disc herniation ultimately, needs surgical treatment, and most patients can get better after conservative treatment [1]. In conservative treatment, physical therapy can significantly relieve the pain and discomfort in the waist and legs of patients with lumbar disc herniation and improve the quality of life. Water-filtered infrared-A (wIRA) therapy is an effective way of thermal radiation therapy, which has the characteristics of high tissue penetration and low body surface temperature load. Water-filtered infrared-A treatment can not only increase deep tissue temperature and local tissue Oxygen partial pressure, it improves tissue perfusion, reduce local pain, reduce inflammation reaction and exudation and can also induce passive immunological effects [2;3]. Acute and chronic soft tissue injuries can be effectively treated by the combination of thermal effects and non-thermal effects of water-filtered infrared-A. The treatment of non-specific inflammation and limited mobility in patients with herniation is of great significance. This study observed the improvement effect of water-filtered infrared-A on the pain and quality of life of patients with lumbar intervertebral disc herniation in Zhongguancun Hospital in recent years. The patients treated with common local infrared rays were used as controls. This study provides the basis for the clinical treatment of lumbar disc herniation.

1 Materials and methods

1.1 Clinical data select

100 patients with lumbar intervertebral discs received from June 2014 to June 2016 physical therapy in the department of spine of Zhongguancun hospital. Inclusion criteria: ① low back pain and radiating pain in lower extremities. ② lumbar disc herniation confirmed by MRI images. ③ under 65 years old. ④ signed, informed, consent for treatment. Exclusion criteria: ① previous history of lumbar surgery was internal fixation. ② infection, pregnancy, malignant tumor, mental illness. ③ severe cardiovascular, liver and kidney diseases. ④ inability to complete the full course of treatment.

100 patients were divided into whole-body water-filtered infrared-A group and common infrared group by **random number table method**, **50 cases in each group**. In the water-filtered infrared-A group, there were 28 males and 22 females with an average age of 51.03 ± 7.21 years. 23 cases had left lower limb involvement and 27 cases had right lower limb involvement and the course of disease was 32.65 ± 4.73 months. In the common infrared group 26 males and 24 females with an average age of 52.10 ± 6.38 years, 24 cases had left lower limb involvement and 26 cases had right, lower limb involvement and the cause of disease was 31.37 ± 5.16 months. There was no significant difference in general data between the two groups $P < 0.05$.

1.2 Treatments methods

1.2.1 Water-filtered infrared-A group uses the VON ARDENNE whole-body hyperthermia system IRATHERM1000 infrared radiation therapy device. According to the standard operation method of the device the light source of the therapeutic device is installed at a distance of about 50 cm from the skin, **therapy time is 20 min once a day, five times a week for 4 weeks**.

1.2.2 Common infrared group uses conventional infrared radiation equipment 500 infrared radiation treatment device from Hydrosun medical technology Co. Ltd and performs local skin irradiation according to the operating specifications. Set light source is 30-50 cm away from the skin, therapy time is 20 min once a day, five times a week for 4 weeks.

1.3 Efficacy of evaluation

Evaluation of curative effect before and after treatment: The pain degree, Quality of life, lumbar spine activity (front flexion, posterior extension) and straight leg elevation, raising test angle of the two groups of patients who were measured and scored to count the patient score.

1.3.1 The visual analog scale (VAS) was used for pain evaluation with a 10 cm long straight line [4]. The two ends indicate "no pain" and "unbearable severe pain" respectively. Corresponding marks are made on the straight line and the distance from the "painless" end indicates the degree of pain. 0 points: no pain. Below 3 points: slight pain, which can be tolerated. 4-6 points: pain affects sleep, but can be tolerated. 7-10 points: strong pain, pain is unbearable, seriously affects appetite and sleep.

1.3.2 The assessment of quality of life adopts the SF-36 concise health questionnaire [5;6] which is widely used for the evaluation of quality of life, clinical trial results and clinical efficacy of patients with various diseases and includes 36 questions and 8 dimensions (physiological function, social functioning, physical functioning, physical pain, mental-emotional functioning, vitality, general health).

1.3.3 Measurement of lumbar range of motion and straight leg raise in test. Lumbar range of motion includes angles of flexion and extension and the angle of straight leg raising test refers to the angle when the lower limb on the affected side is raised with pain. Before and after treatment, use the general amount angel measurement, continuous measurement of forward flexion, rear extension and straight leg elevation angles times, the mean values are taken.

1.4 Statistical analysis

SPSS 19.0 software was used for statistical analysis. The measurement data were expressed as mean and standard deviation, paired sample (test) was used for comparison between groups, count data was expressed as a rate and chi-square test was used for comparison between groups. $P < 0.05$ indicates a significant difference.

2 Results

Before treatment, there was no significant difference in VAS scores and SF -36 scores between the two groups ($P > 0.05$). After treatment, the VAS scores and SF -36 scores of the two groups were significantly improved compared with those before treatment. The improvement in the water-filtered infrared-A group was significantly better than that in the common infrared group and the differences were significant ($P < 0.05$, **Table 1**). Before treatment, there was no significant difference in the angles of lumbar flexion, extension and straight leg, raising test between the two groups ($P > 0.05$). After treatment the lumbar flexion, extension and straight leg raising test angles of the two groups of patients were significantly improved, compared with those before treatment, and the difference was significant ($P < 0.05$). The degree of improvement in the leg raising test in the water-filtered infrared-A group was significantly better than that of the common infrared group, the difference was significant ($P < 0.05$). But there was no significant difference in the change of the lumbar extension angle between the two groups ($P > 0.05$, **Table 2**).

Table 1 comparison of VAS and SF -36 scores before and after treatment in the two groups (points, mean $\pm$ s, n = 50)

Group	VAS score	SF-36 score
Common infrared group		
Before treatment	4.98 $\pm$ 0.97	238 $\pm$ 98
After Treatment	3.09 $\pm$ 1.43*	347 $\pm$ 101*
Difference	2.38 $\pm$ 1.71	116 $\pm$ 103
water-filtered infrared-A group		
Before treatment	5.22 $\pm$ 1.64	223 $\pm$ 93
After Treatment	1.71 $\pm$ 1.55*#	422 $\pm$ 132*#
Difference	4.13 $\pm$ 1.47#	203 $\pm$ 126#

Table 2 lumbar flexion and extension range of motion straight leg racing test before and after treatment angle comparison (mean $\pm$ s, n = 50)

lumbar flexion	lumbar extension	strait leg raise test
35.37 $\pm$ 2.26	14.36 $\pm$ 2.43	32.27 $\pm$ 9.20
50.51 $\pm$ 7.44*	19.67 $\pm$ 1.63*	58.83 $\pm$ 5.53*
18.16 $\pm$ 4.39	6.07 $\pm$ 2.41	28.93 $\pm$ 7.41
33.13 $\pm$ 3.34	15.65 $\pm$ 3.13	35.37 $\pm$ 8.87
62.30 $\pm$ 4.58*#	20.43 $\pm$ 2.26*	76.53 $\pm$ 4.29*#
31.17 $\pm$ 3.37#	6.32 $\pm$ 1.96	45.92 $\pm$ 6.46#

Note: * compared with before treatment $P < 0.05$; # compared with common infrared group $P < 0.05$

3 Discussion

Lumbar disc herniation cause cause lumbago and leg pain due to many factors, nerve roots and dural sac are directly stimulated by mechanical compression of protrusions, nerve tissue blood supply disorder, local nerve root inflammatory stimulation and immune response are all associated with pain. In non-surgical treatment thermotherapy can effectively improve local blood circulation, relieve muscular spasm and relieve pain. Infrared therapy can be a good and stable heat source, which is a routine choice for clinical thermotherapy. Infrared radiation can be divided into three bands according to the wavelengths, namely infrared-A (wavelength 760-1400nm), infrared-B (1400-3000nm) and infrared-C (3000nm-1mm). The Penetration power is directly proportional to its frequency. Therefore, the infrared-A-band can go deep into the dermis and subcutaneous tissue, reach the blood vessels, and convert it into heat. The heat spreads in the body with the help of blood flow, so that the body-core temperature can be safely and quickly raised. Whereas the B-band and C-band radiation only delayed reach the dermis and subcutaneous tissue, their energy is nearly complete absorbed by the stratum corneum and germinal layer, can causing a local burning sensation by heat overload. Therefore, in clinical work we need the A-band infrared as an effective treatment method and should reduce or avoid the adverse reactions of B- and C-bands. The water-filtered infrared-A therapy system is based on this principle, that through the water filter layer an effectively filter out of the infrared-B and -C bands in the halogen lamp radiation is realized. Studies have found that water-filtered infrared-A treatment can increase the tissue temperature until 2 cm subcutaneously by about 2.7°C, and increase the oxygen partial pressure by about 32%, without burning the local skin [7]. The heat energy can be radiated to 7 cm subcutaneously, and the body-core temperature can be maintained until around 41°C. This is an effect that other physical therapy methods cannot achieve [8;9]. Through effective heat radiation, it can reduce the local sympathetic nerves tension, establish a good collateral circulation, increase the oxygen partial pressure, can relieve local pain by improving tissue perfusion, improve function and quality of life [10;11].

In addition to the thermal effect of water-filtered infrared-A therapy, there are further effects. This are non-thermal effects which can directly stimulate cellular immune functions, stimulate immune cells and reduce the immunosuppression. At same time infrared-A can regulate cytochrome C oxidase and promote the growth and function recovery of nerve cells [7;12].

The results of the study show that nonsurgical treatment of intervertebral disc herniation with whole-body water-filtered infrared-A can effectively relieve pain and improve the quality of life of patients.

The study shows that the curative effect with whole-body water-filtered infrared-A therapy has obvious advantages compared with common infrared therapy and it is worthy for a clinical promotion.

References

- [1] 方卫军, 李章华. 腰椎间盘突出症的微创治疗进展[J]. 中国医药导报, 2016, 13 (22): 24-27.
- [2] Hartel M, Illing P, Mercer JB, et al. Therapy of acute wounds with water -filtered infrared -A (wIRA)[J]. GMS Krankenhhyg Interdiszip, 2007, 2(2):Doc53.
- [3] Winkel R, Hoffmann G, Hoffmann R. Water-filtered infrared -A (wIRA) promotes wound healing [J]. Chirurg, 2014, 85(11):980-992.
- [4] Williams ACC, Davies HT, Chadury Y. Simple pain rating scales hide complex idiosyncratic meanings[J]. Pain, 2000, 85(3):457-463.
- [5] Ware JE, Snow KK, Kosinski M, et al. SF-36 Health Survey. Manual and Interpretation Guide[M]// Boston, MA: New England Medical Center, Health Institute, 1993. 11-12.
- [6] 叶超群, 孙天胜, 李放, 等. SF-36简明健康问卷在几种骨关节疾病患者中的应用研究[J]. 中国康复医学杂志, 2012, 27 (12): 1111-1115.
- [7] Hoffmann G. Wassergefiltertes Infrarot A in Chirurgie, Dermatologie, Sportmedizin und weiteren Bereichen[EB/OL]. [2017-10-07]. <https://core.ac.uk/download/pdf/14524098.pdf>.
- [8] Hoffmann G. Principles and working mechanisms of water-filtered infrared-A (wIRA) in relation to wound healing[J]. GMS Krankenhhyg Interdiszip, 2007, 2(2):Doc54.
- [9] Daeschlein G, Alborova J, Patzelt A, et al. Kinetics of physiological skin flora in a suction blister wound model on healthy subjects after treatment with water-filtered infrared-A radiation[J]. Skin Pharmacol Physiol, 2012, 25(2):73-77.
- [10] Von Felbert V, Schumann H, Mercer JB, et al. Therapy of chronic wounds with water -filtered infrared-A (wIRA) [J]. GMS Krankenhhyg Interdiszip, 2008, 2(2):Doc52.
- [11] Mercer JB, Nielsen SP, Hoffmann G. Improvement of wound healing by water-filtered infrared-A (wIRA) in patients with chronic venous stasis ulcers of the lower legs including evaluation using infrared thermography [J]. Ger Med Sci, 2008, 6:Doc11.
- [12] Hoffmann G. Water-filtered infrared-A (wIRA) in acute and chronic wounds[J]. GMS Krankenhhyg Interdiszip, 2009, 4(2): Doc12.