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THE EFFECTS OF INFRARED LASER THERAPY AND WEIGHTBATH TRACTION HYDROTHERAPY IN DISORDERS OF THE LUMBAR SPINE: A CONTROLLED PILOT STUDY WITH FOLLOW-UP

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Abstract

Introduction: The therapeutic modalities available for the conservative management of chronic lumbar pain included infrared laser therapy and underwater traction, which usefulness is not universally acknowledged. This study was intended to ascertain any beneficial impact of infrared laser therapy and weightbath treatment on the clinical aprameters and quality of life of patients with lumbar discopathy.

Material and methods: The study population comprised 54 randomised subjects. I. group of 18 patents received only infrared laser therapy to lumbar region and painful Valley points. II. Group of 18 subjects each received underwater traction therapy of lumbar spine with add-on McKenzie exercise and iontophoresis. The remaining III. Group treated with exercise and iontophoresis, served as control.

VAS, Oswestry index, SF36 scores, range of motion, neurological findings and thermography were monitored to appraise therapeutic afficacy in lumbar discopathy. A CT or MRI scan was done at baseline and after 3 months follow-up.

Result: infrared laser therapy and underwater traction for discopathy achieved significant improvement of all study parameters, which was evident 3 months later. Among the controls, significant improvement of only a single parameter was seen in patients with lumbar discopathy.

Conclusions: infrared laser therapy and underwater traction treatment effectively mitigate pain, muscle spasms, enhance joint flexibility, and improve the quality of life of patients with lumbar discopathy.

Introduction

Low back pain and sciatica comprise the second most frequent reason for seeking medical advice. The chance for contracting lumbosacral complaints is between 60 to 90 per cent during a lifetime; annual incidence is 5 percent. In 90 per cent of cases, symptoms resolve over 2 to 4 weeks, but recur within a year in 70 per cent[1,2,3,4]. The predominant underlying causes of these symptoms are the protrusion or the herniation of intervertebral discs. The

management options of lumbar and radicular pain include conservative treatment, surgical therapy, and invasive neurointervention procedures. When herniation causes paresis through the compression of nerve roots or results in myelopathic symptoms, fecal or urinary incontinence, or the cauda equina syndrome, prompt surgical intervention – i.e. open or minimally invasive discectomy – is recommended[4]. In absence of these symptoms, various nucleoplasty techniques are performed; however, the long-term outcome of these is still questionable and the strength of supporting evidence remains below Level I. The alternative is conservative management, usually consisting of pharmacotherapy (including infusion therapy), physical therapy, and various forms of remedial gymnastics[5,6]. In Hungary and in Hungarian rheumatology institutions, the range of conservative treatment modalities also includes weightbath traction, along with soft laser therapy.

Notwithstanding its long tradition, recent review articles evaluating non-immersion (motorized, auto-, or gravitational) traction therapy have disapproved the use of this modality for the management of spinal complaints, in view of its potential hazards[7,8,9].

Underwater traction hydrotherapy was invented by the Hungarian rheumatologist, Károly Moll, who has been developing this treatment since the fifties of the last century into a therapeutic option widely used in many rheumatology and balneology centers in Hungary[10]. Among the latter, Hajdúszoboszló spa resort is one of the institutions that have accumulated the widest experience with this treatment modality. In contrast to non-immersion traction, weightbath traction hydrotherapy in tepid to warm water affords improving the patient's condition without any risk. Previous biophysical studies have measured (taking into account the patient's body weight, hydrostatical forces and buoyancy effect) the traction forces exerted on individual spinal segments. Additionally, Hungarian bioengineers have determined optimum loading, as well as the load-bearing capacity and deformability of various spinal compartments[11,12].

Weightbath hydrotherapy in warm water relaxes muscles and ligaments, whereas moderate and sparing traction – aided by the protective effect of hydrostatical pressure – accomplishes retraction of intervertebral disc protrusions and herniations; relieves the tension of nerve root canals; as well as mitigates axial and radicular pain.

Since years, we have been using soft laser therapy on cervical, thoracic, and lumbar segments of the spine to relieve pain, to relax muscles and to control inflammation. A number of Hungarian academic researchers have contributed to the development of soft laser treatments.

The term 'biostimulation' has been coined by Prof. Endre Mester 25 years ago to describe specific phenomena underlying the healing processes observed during soft laser therapy. The phenomenon of biostimulation is implemented by reversible cell physiological processes, activated – among others – by the laser beam. The effect of repetitive biostimulation is cumulative. As shown by the results of experiments, laser stimulation elicits repair processes in specific or multiple levels of deranged cellular metabolism. Soft laser facilitates the restoration of original – physiological – reparative functions. The initiation of such processes is believed to occur at the level of terminal oxidation, in the mitochondria. Healing is not restricted to topical only processes – it is influenced by a variety of systemic factors. In addition to biostimulation, soft laser therapy exerts anti-inflammatory action, it relieves muscle spasm, and it has a direct analgesic effect.

Patients & methods

We have conducted a pilot study with follow-up on rheumatology outpatients. Weightbath traction hydrotherapy was performed at the Hajdúszoboszló spa resort, whereas the control and laser therapy groups were treated at the Borsod County University Teaching Hospital in Miskolc. The study protocol was approved by the regional ethics board.

Patients over 18 years of age, with lumbar pain radiating to the lower extremities – demonstrated by MRI to result from lumbar discopathy – were enrolled into the study. Patients with any acute condition considered an indication for surgery, those with spondylolisthesis, oseteoporosis causing vertebral compression, spondylitis, malignancies or other severe systemic disorders were not included. Patients who had undergone previous surgery of the spine were not enrolled either.

Eligible patients were randomized into three groups of 18 subjects each:

1. Standard control group: patients in this group were treated with McKenzie remedial gymnastics (20-minute sessions) and iontophoresis for 3 weeks.
2. Weightbath traction hydrotherapy group: in addition to the remedial gymnastics and iontophoresis described above, these patients underwent underwater traction on 15 occasions.
3. Soft laser group: these patients were treated exclusively with infrared laser illumination of the lumbar region and Valleix's points.

Paracetamol was allowed for use as a rescue analgesic in all three groups. The first session of weightbath traction hydrotherapy was implemented with single (cervical) suspension, without extra weights, whereas during subsequent sessions, triple suspension (cervical plus armpit support) was used with 2×3 kg weight affixed to the waist belt. The duration of the initial session was 15 minutes – this was extended to 20 minutes for subsequent sessions. The temperature of the water bath was 34 °C. Laser treatment for 15 days was performed using a 600 mW KLS equipment (Fajro), delivering 30 J infrared illumination to the lumbar region (with a laser shower head containing 6 laser diodes) and 2 J/point to painful Valleix's points (with a single-point laser head).

The neurological status of patients was checked daily, as well as their complete medical and neurological status was recorded before and after each treatment session. Additionally, the subjects completed the SF-36 questionnaire and the Oswestry disability index before treatment. VAS scores, finger-floor distance, the range of lateral flexion (shifting of the patient's hand placed on the thigh in centimeters) were recorded. The physicians' rating of the condition of their patients, as well as the subjective opinion of the latter on their own well-being was obtained through interviews. In the standard control and in the weightbath hydrotherapy groups, these parameters were recorded again 3 months after treatment and follow-up MRI was performed. In the laser group, thermographic images were recorded at baseline as well as after treatment.

Statistical analysis

The normality of study parameters was checked with the one-tailed Kolmogorov–Smirnoff test. The Mann–Whitney or the t-test was used for the comparison of baseline values. Changes were analyzed with the paired Student's t-test or Wilcoxon's signed rank test.

Results

In the control group the beneficial effect was significant on just a single parameter (floor-finger distance), and significant improvement of only two parameters (Oswestry index and SF-VT) was ascertained 3 months later *(Table 1)*. All parameters improved significantly after weightbath therapy, the improvement proved lasting after 3 months and increased further in the case of two parameters *(Table 2)*. All clinical parameters improved after infrared laser therapy, 9 parameters significantly *(Table 3)*.

Parameter	At baseline (mean±SD)	After treatment (mean±SD)	After 3-month follow-up (mean±SD)	p-value		
				After treatment vs. baseline	After 3-month follow-up vs. baseline	After 3-month follow-up vs. post-treatment
VAS	5.28±1.87	5.72±1.87	5.39±2.20	NS	NS	NS
Floor-finger distance	42.22±14.07	37.06±14.29	39.39±16.20	0.029	NS	NS
Lateral flexion LEFT	15.17±4.84	16.78±3.67	15.78±4.26	NS	NS	NS
Lateral flexion RIGHT	15.67±4.34	17.11±4.09	17.22±4.01	NS	NS	NS
Oswestry Index	67.11±12.60	66.67±17.78	72.33±13.83	NS	0.022	0.041
SF-PF: physical functioning	48.61±18.93	51.67±20.93	53.33±21.83	NS	NS	NS
SF-RP: role limitations – physical	27.50±34.22	20.83±32.37	31.94±35.15	NS	NS	NS
SF-RE: role limitations – emotional	31.33±36.96	25.83±38.81	27.72±41.61	NS	NS	NS
SF-VT: vitality	32.11±20.97	37.50±26.58	41.39±25.19	NS	0.008	NS
SF-MH: mental health	51.50±31.98	46.67±31.11	53.00±30.39	NS	NS	NS
SF-SF: social functioning	49.78±32.13	48.39±32.16	56.33±30.25	NS	NS	NS
SF-BP: bodily pain	40.28±18.19	40.94±16.71	48.11±16.50	NS	NS	NS
SF-GH:general medical health	31.56±18.47	31.78±17.91	35.44±21.32	NS	NS	NS

Table 1. Control group with lumbar discopathy

Parameter	At baseline (mean±SD)	After treatment (mean±SD)	After 3-month follow-up (mean±SD)	p-value		
				After treatment vs. baseline	After 3-month follow-up vs. baseline	After 3-month follow-up vs. post-treatment
VAS	7.94±1.47	3.06±2.67	2.41±2.48	0.000	0.000	NS
Floor-finger distance	32.50±16.40	14.06±12.68	11.29±12.46	0.000	0.000	NS
Lateral flexion LEFT	12.22±4.01	18.11±5.09	21.59±5.20	0.000	0.000	0,005
Lateral flexion RIGHT	12.94±4.68	18.50±4.88	21.65±5.28	0.001	0.000	0,017
Oswestry Index	52.17±24.91	79.33±16.12	81.59±15.55	0.001	0.001	NS
SF-PF: physical functioning	33.06±20.08	68.89±20.97	68.24±27.27	0.005	0.000	NS
SF-RP: role limitations – physical	15.28±28.62	44.44±43.35	58.82±42.34	0.011	0.003	NS
SF-RE: role limitations – emotional	27.67±39.94	62.83±44.12	64.59±43.28	0.007	0.007	NS
SF-VT: vitality	41.39±22.41	62.78±26.80	62.06±28.56	0.007	0.009	NS
SF-MH: mental health	47.56±24.46	74.44±22.72	73.65±26.00	0.001	0.000	NS
SF-SF: social functioning	51.22±27.43	73.44±23.10	74.88±24.97	0.005	0.024	NS
SF-BP: bodily pain	35.06±18.10	66.17±21.65	64.18±20.50	0.000	0.000	NS
SF-GH:general medical health	42.50±21.23	55.00±23.83	57.35±24.76	0.022	0.006	NS

Table 2. Weightbath therapy for lumbar discopathy

Parameter	At baseline (mean±SD)	After treatment (mean±SD)	p-value
			After treatment vs. baseline
VAS	6,93±2,37	3,93±2,46	0,000
Floor-finger distance	32,93±10,15	18,00±9,51	0,000
Lateral flexion LEFT	13,00±3,04	18,93±5,96	0,000
Lateral flexion RIGHT	14,27±4,62	19,33±6,30	0,000
Oswestry Index	64,93±16,01	80,13±16,67	0,002
SF-PF: physical functioning	45,00±26,11	60,33±24,16	0,008
SF-RP: role limitations – physical	16,67±34,75	51,67±48,51	0,027
SF-RE: role limitations – emotional	22,22±41,00	42,22±46,23	NS
SF-VT: vitality	41,33±19,50	49,33±49,32	NS
SF-MH: mental health	47,73±23,20	58,13±18,61	NS
SF-SF: social functioning	50,90±26,50	70,83±24,85	0,008
SF-BP: bodily pain	36,00±17,33	55,33±23,73	0,015
SF-GH: general medical health	35,33±17,16	41,00±21,88	NS

Table 3. Laser therapy for lumbar discopathy

Discussion

As shown by a previous biophysical study performed with a special ultrasound device for underwater use, moderate loading (with 4 kg weight) accomplished a 0.9 to 1.6 mm increase of disc height in 75 per cent of patients. The deformation of the disc peaked after approx. 20 minutes. In view of the foregoing, it is expedient to implement loading with smaller weight, but over a prolonged period[11,12].

Underwater traction affords both symptomatic relief and causal therapy simultaneously; it is particularly suitable for the alleviation of axial pain. The retraction of protruding intervertebral discs slightly eases the pressure on nerve roots and accordingly, radicular pain is relieved along with local vertebral pain, as well as with muscle spasm, and the pressure in spinal compartments.

Laser therapy alleviates muscle spasm; it exerts a direct analgesic action as well as anti-inflammatory and neuroregenerative effects[13,14,15,16,17]. These properties we found useful in reducing both vertebral and radicular pain. There have been a number of mechanisms investigated in attempts to determine how disc herniations heal. Histological investigations have shown the presence of granulation tissue with abundant vascularization surrounding the fibrocartilaginous fragments. Within the granulation tissue, the prevailing cell types are macrophages with fibroblasts endothelial cells. These cell types have been demonstrated to be positively affected by laser therapy. The stimulation of marophages and fibroblasts could be the primary mechanism by which laser therapy heals disc herniations[18]. Inflammatory markers such as IL-1, IL-6 and TNF are also present at the site of disc herniations, laeding to higher prostaglandin E2 concentrations. Two studies have demonstrated that laser therapy effective in reducing prostaglandin E2 concentrations[19,20].

Both treatment modalities were superior to the therapy administered in the standard control group. Both the patients and their physicians agreed that weightbath traction and laser therapy improved the patients' condition more rapidly and intensely. Compared to the controls, patients in the laser therapy and weightbath hydrotherapy groups used much less rescue medication, which did not cause any gastric complaints or ulcer symptoms in these subjects. In the standard control group by contrast, paracetamol-induced gastric complaints were observed in two patients. The favorable outcome of therapy persisted longer in the weightbath hydrotherapy group – the significantly improved subjective and objective status was maintained even 3 months after treatment. In the majority of cases, the follow-up MRI repeated 3 months after treatment did not depict any substantial difference compared to baseline – the reduction of disc protrusion/herniation was seen in a few cases only. According to the literature, an increase in the distance between individual vertebrae was verified using a special, underwater US equipment and furthermore, MRI performed immediately after treatment depicted reduced disc protrusion/herniation. However, this radiologically evident improvement was no longer evident 3 months later.

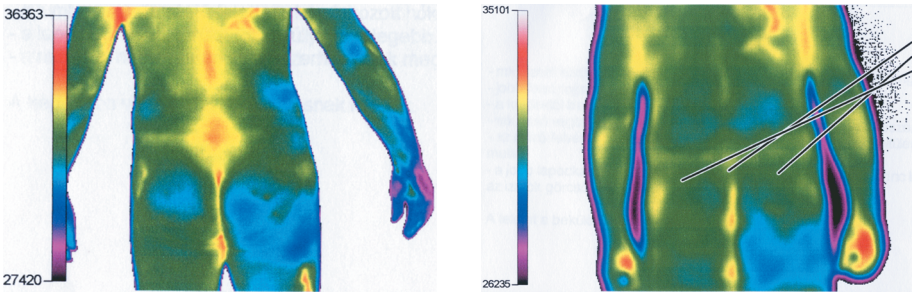
In the laser group, improvement and the relief of pain was confirmed by thermography, which showed attenuation in higher temperature ranges in the paralumbar segment and in regions corresponding to nerve roots.

Both weightbath traction hydrotherapy and laser therapy accomplished a statistically significant reduction of lumbar and radicular pain, as well as mitigated paresthesia. The range of motion of the lumbar segment increased simultaneously. SF-36 scores and Oswestry indexes both improved. The relief of symptoms was associated with improved qual-

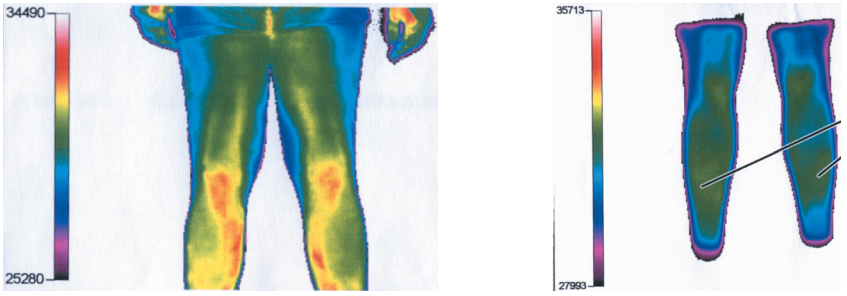
Thermographic pictures (4 patients)

Before treatment

After treatment



Patient No. 1.



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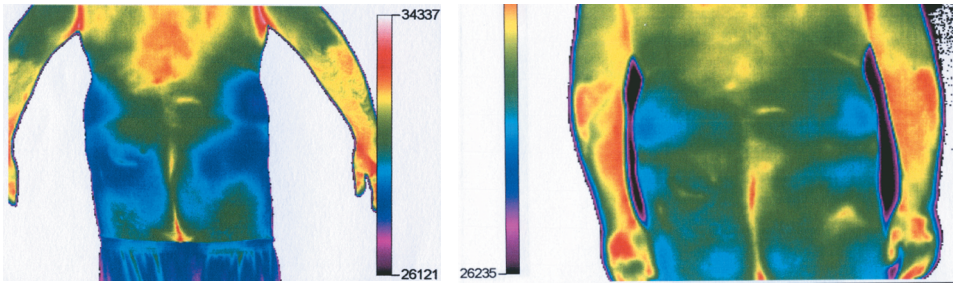
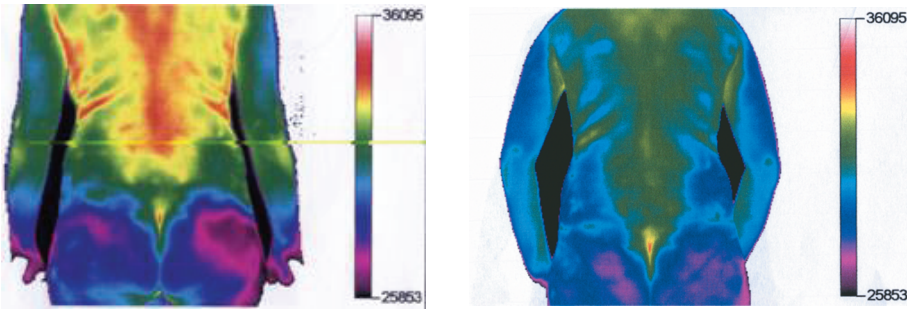


Patient No. 3.



Patient No. 4.

ity of life and enabled the patients to resume their everyday activities, as well as reduced their absenteeism from work.

Conclusion

Both soft laser illumination and underwater traction hydrotherapy exert their beneficial action promptly. These are easy to implement, low-cost, and non-invasive treatment modalities devoid of any relevant hazard. Considering that both relieve pain and increase articular range of motion, we recommended integrating these treatments into the algorithm of conservative management. Additionally, we suggest conducting additional studies to confirm the beneficial effect of these treatments – with special emphasis on the combined use of underwater traction and soft laser therapy.

REFERENCES

1. *Koes BW, Van Tulder MW, Thomas S.* Diagnosis and treatment of low back pain. BMJ 2006; 332:1430–1434.

2. *Van Tulder M.* Low back pain. Best Practice & Research in Clinical Rheumatology 2002;16:761.

3. *Hicks GS, Duddleston DN, Russell LD, Holman HE, Shepherd JM, Brown CA.* Low back pain. AmJ Med Sci 2002;324:207–211.

4. *Greeenberg MS.* Handbook of Neurosurgery. 5th edition. Thieme 2001.

5. *Li LC* & *Bombardier C.* Physical therapy management of low back pain: an exploratory survey of therapist approaches. Phys Ther 2001;81:1018–1027.

6. *Van Tulder MW, Koes B, Malmivaara A.* Outcome of non-invasive treatment modalities on back pain: an evidence-based review. Eur Spine J. 2006;15(Suppl)1:64–81.

7. *Harte AA, Baxter GD, Gracey JH.* The efficacy of traction for back pain: a systematic review of randomized controlled trials. Arch Phys Med Rehabil 2003;84:1542–53.

8. *Beurskens AJ, de Vet HC, Koke AJ et al.* Efficacy of traction for non-specific low back pain: a randomised clinical trial. Lancet 1995;346:1596–1600.

9. *Clarke JA, van Tulder MW, Blomberg SEI, de Vet HCW, van der Heijden GJMG, Bronfort G.* Traction for low-back pain with or without sciatica. COCHRANE DATABASE OF SYSTEMATIC REVIEWS (4): Art. No. CD003010 2005.

10. *Moll K.* Treatment of discushernia with so-called "weightbath" therapy. Orvosi Hetilap 1953; 94:292–296 (in Hungarian).

11. *Kurutz M, Bene E, Lovas A.* In vivo deformability of human lumbar spine segments in pure centric tension, measured during traction bath therapy. Acta of Bioengineering and Biomechanics 2003;5:67–92.

12. *Kurutz M.* Age-sensitivity of time-related in vivo deformability of human lumbar motion segments and discs in pure centric tension. Journal of Biomechanics 2006;39:147–157.

13. *Soriano F, Rios R.* Gallium Arsenide laser treatment of chronic low back pain: a prospective, randomized and double blind study. Laser Therapy, 1998;l0:175–180.

14. *Basford JR, Sheffield CG, Harmsen WS.* Laser therapy: a randomized, controlled trial of the effects of low-intensity Nd: YAG laser irradiation on musculoskeletal back pain. Arch Phys Med Rehabil, 1999;80(6):647–52.

15. *Toya S., Motegi M, Inomata K, Ohshiro T, Maeda T.* Report on a computer randomized double blind trial todetermine the effectiveness of the GaA1As (830 nm) diode laser for attenuation in selectedpain groups. Laser Therapy, 1994;6:43–148.

16. *Djavid GE, Mehrdad R, Ghasemi M, Hasan-Zadeh H, Sotoodeh-Manesh A, Pouryaghoub G.* In chronic low black pain, low level laser therapy combined with exercise is more beneficial than exercise alone in the long term: a randomized trial. Aust J Physiother, 2007;53(39): 155–60.

17. *Gur A, Krakoc M, Cevik R, Nas K, Sarac AJ, Karakoc M.* Efficacy of low power laser therapy and exercise on pain and functions in chronic low back pain. Lasers Surg Med, 2003;32(39): 233–38.

18. *Young S, Bolton P, Dyson M, Harvey WDiamantopoulos C.* Macrophage responsiveness to light therapy. Lasers Surg Med,1989;9(5):497–505.

19. *Lim W, Lee S, Kim I, Chung M, Kim M, Lim H, Park J, Kim O, Choi H.* The inflammatory mechanismof 635 nm light-emmiting-diode irradiation compared with existing COX inhibitors. Lasers Surg Med, 2007;39(7):614–21.

20. *Bjordal JM, Lopes-Martins RA, Iversen VV.* A randomized, placebo controlled trial of low level laser therapy for activated Achilles tendonitis with microdialysis measurement of peritendinous prostaglandin E2 concentration. Br J Sports Med, 2006;40(1):76–80.

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