ECOCYCLES
ISSN 2416-2140

OPEN ACCESS
Scientific journal of the
European Ecocycles Society

Ecocycles, Vol. 10, No. 2, pp. 40-50, 2024
DOI: 10.19040/ecocycles.v10i2.392

CASE STUDY

Traction treatment, underwater traction therapy, weight bath cabin

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Abstract – Thermal waters are important and multifunctional natural resources for renewable energy, recreation, health-tourism and their use in balneotherapy is particularly well known. Many degenerative spine diseases can be successfully treated with traction treatments. As a result of traction, the height of the discs adjusts, the disc protrusions retract, and canals of the nerve roots expand. Compared to dry traction treatment, underwater traction treatment has many advantages. Due to the effect of warm water, we do not have to count on muscle protection. Thanks to the buoyant force, a very careful traction can be achieved. Thanks to this, this treatment can be considered the safest and most effective traction treatment. With our innovative weight bath cabin, you can carry out an individualized, safe and successful weight bath treatment. In our weight bath cabin, we can effectively combine traction treatment and medicinal water treatment.

Keywords – traction, underwater traction therapy, spine, weight bath cabin, balneotherapy

Received: January 2. 2024 Accepted: July 11, 2024

INTRODUCTION

Thermal water utilization constitutes an important part of designed ecological cycle processes, which should aim at multi-purpose use and reuse and water saving. Here we present an innovation in balneology, combining underwater traction therapy and medicinal water treatment. Approximately 60-85% of individuals experience lower back pain at some point in their lives. Of these cases, around 90% are resolved after a period of 2-4 weeks. However, a significant proportion, ranging from 60-80%, experience a recurrence of the pain within one year. The prevalence of cervical spine discomfort is 13%, and more than 50% of individuals experience recurring issues. These problems are a prevalent cause for medical evaluations and absenteeism worldwide. Due to its significant size and significance, it is considered one of the primary focal points in the healthcare sector. Scientists have devised multiple conservative and surgical remedies to address various spinal conditions.

TRACTION TREATMENT

Traction therapy, sometimes referred to as spinal stretching treatments, is widely utilized worldwide for many purposes (Borman et al, 2004; Wegner et al., 2013; van Tulden et al., 2006). Stretching in the same direction as the longitudinal axis of the body was already used by Hippocrates for healing (Fig. 1). The traction device invented by Hippocrates, which employed cables looped over the chest and pelvis to stretch immobilized patients, continued to be utilized until the Middle Ages. Unfortunately, during the Dark Ages, this method was mainly used for torture and interrogations. The neck stretcher developed by Glisson is a treatment that has been practiced for millennia. Meanwhile, lying down stretching techniques have been increasingly popular, particularly among the French. These methods have been automated more recently and are known to be quite effective, if unpleasant. The traction process can be mechanized, utilizing either powered, auto traction, or gravity traction methods.

Since the 20th century, it has become one of the most common conservative spine treatment procedures in all parts of the world, both in the lumbar spine and in the cervical spine (Cai et al., 2009; Constontoyannis et al., 2002; Deyo, Gay et al., 2008; Gillström et al., 1985). Judovich and Nobel performed the first biomechanical tests on cadavers (in 1957) and they first proposed the use of a split table, which could

significantly reduce friction. In 1969, Colachis and Strohm provided evidence that applying traction in the Fowler position on the lumbar area resulted in a reduction of disc height in the front of the disc, while causing an increase in the back half. The impact was greatly influenced by the patient's lumbar lordosis. Based on their research, the lumbar spine reverted back to its initial condition within a span of 10 minutes following the treatment. In his 1979 study, Reilly found that increasing hip flexion resulted in more success in elongating the lumbar spine when utilizing the same traction. In 1985, Twomey saw through cadaver tests that the lumbar region reverted back to its original condition within 30 minutes after the therapy concluded.

According to Cyriax's theory, during the traction treatment, negative pressure is generated inside the nucleus pulposus, and this pulls back the disc protrusion or herniation Gudavalli et al., 1997; Kroeber et al., 2005). Subsequent biometric tests did not confirm this, and in fact, several tests confirmed that the spinal muscles contract as a result of traction and that the pressure inside the disc increases (Andersson, 1983, Ramos 1994). Some imaging tests have confirmed that traction treatment reduces the protrusion of the disc (Adams et al. 2000; Kurutz and Bender, 2010; Hadzic et al. 2021; Wang et al. 2022).

Figure 1. Traction treatment of Hippocrates. Source: Vasiliadis et al. 2009. From the illustrated comments of Apollonius of Kitium on the Hippocratic treatise On Articulations. Bibliotheca Medica Laurenziana, Florence. (Image digitally reprocessed for higher resolution). https://doi.org/10.1186/1748-7161-4-6

Traction therapies are generally performed by physical therapy assistants, chiropractors, or performed by physiotherapists (Gagne et al.,2010; Madson et al.,2015). Traction therapy is utilized in 7% of spinal complaint cases in Great Britain, 30% in Canada, and 21% in the USA as part of conservative treatments. The majority of insurance companies in the United States provide funding for traction therapy to address spinal issues. A multitude of traction treatment devices have received FDA clearance. Various nations tend to favor specific methods, techniques, and equipment for traction therapy, resulting in the emergence of numerous distinct forms of traction treatment (Che et al., 2022; Harte et al., 2005; Iatridis et al., 2005).

Traction therapies can be categorized as continuous (lasting for hours to days), temporary (with a duration of 20-60 minutes), or intermittent, involving alternating periods of traction and relaxation. The treatment options can vary dependent on the degree of pulling and may include axial, positional, distraction-based, or a mix of distraction and manipulation techniques. The majority of locations execute the pull by utilizing 30-50% of the patient's whole-body weight. Traction treatments are primarily used for spine treatment (Liu et al., 2021). Traction treatment of the small and large joints of the limbs is also used in smaller numbers, in various medical conditions and injuries.

The treatment options can be categorized based on their length as follows:

(1) Continuous traction treatment

The duration of the treatment often ranges from a few hours to a few days. The therapies entail the utilization of diminutive weights and a constant gentle traction. Certain patients experience challenges in enduring lengthy therapies, while certain treatments prove to be useless. It is primarily used in Southeast Asia, New Zealand, and Australia, according to reports.

(2) Sustained traction

The duration of continuous tugging ranges from a few minutes to half an hour, during which more vigorous pulling is typically employed. Static traction, also known as static tractive force, is widely used in Europe and has various forms that have become widespread (Ozturk et al., 2006; Lee et al.,2001).

(3) Intermittent mechanical traction

Intermittent traction and relaxation are employed, typically with brief intervals of a few seconds, and predominantly utilizing a traction apparatus. This therapy approach has becoming increasingly popular in the United States.

(4) Gravity lumbar traction

This procedure entails utilizing a chest harness to fasten the patient while the treatment table is inclined to a vertical orientation, so employing the gravitational force of the lower body to generate a traction force.

(5) Autotraction

Autotraction employs a specifically engineered table that is partitioned into two pieces, each capable of independent tilting or rotation. The patient generates the traction force by exerting a pulling motion with the arms or a pushing motion with the feet. Research into autotraction has produced positive clinical outcomes (Larsson et al., 1980; Tesio et al.,1993).

(6) Manual traction

The clinician applies manual traction by using their hands or a belt to exert a pulling force on the patient's legs. The practitioner usually administers manual traction for a brief duration. The manual traction treatment entails the utilization of manual force. This treatment mostly focuses on the neck region. An inherent drawback is the lack of precise adjustability in the degree of traction, making the treatment highly dependent on external factors. Overly enthusiastic application of this treatment might potentially lead to problems including disc herniation (Ljunggren et al.,1984).

(7) Positional traction

Traction is applied by positioning the patient in different ways utilizing blocks, cushions, and sandbags to create a longitudinal force on the spinal tissues. Typically, it entails the flexion of the spine to the side, affecting only one side of the spinal segment. Traction can be:

- axial - in the same direction as the axis of the body,
- positioned - stretching performed in a flexion or extension position, mainly applied to the neck area,
- distraction- usually a manual technique positioned on a spinal segment,
- use of distraction-traction treatment mixed with manipulation during manual therapy (Cox technique, Leander technique, Saunders ActiveTrac treatment)
- traction treatment supplemented with vibration.

Improved traction control can be achieved with the implementation of motorized Flower position flit tables and tiltable tables that utilize gravity. Personalized therapies have the potential to enhance both effectiveness and safety. The specialized team, consisting of a clinician, radiologist, and physiotherapist, is capable of administering treatments with accurate measurements and control, resulting in improved and safer outcomes.

Figure 2. Bath bench – motorized gravity bed.
Photo: Cs. Oláh

Traction therapies are commonly administered by healthcare facilities as a component of a comprehensive therapy, sometimes in combination with medicine (such as NSAIDs and myorelaxants), other physiotherapy treatments, and patient education (Schimmel et al., 2009).

In many cases, clinical studies have confirmed positive clinical results in the treatment of both the cervical and lumbar regions (Öten et al., 2022; Thackeray et al., 2016; Shaheed et al., 2014; Rattanatharn et al., 2004; Vanti et al., 2023). It is important to note that the traction was frequently applied using distinct approaches and ways (Figs. 2. and 3).

Figure 3. Motorized split traction bed (semi-Fowler's position) Source: Fowler's Position Guide | STERIS

UNDERWATER TRACTION THERAPY

Károly Moll introduced the practice of underwater traction therapy, also known as weight bath treatment, in 1953. Károly Moll underwent therapy at the renowned Hungarian balneological center at Lake Hévíz and observed highly beneficial therapeutic advancements (Fig. 4).

Kurutz M and her colleagues conducted a series of sequential tests to study the biomechanics of the weight bath treatment (Bene et al, 1993; Kurutz et al., 2010). The field of bioengineering has demonstrated the efficacy of underwater traction therapy on the spinal column (Kurutz et al., 2008). The researchers conducted an investigation to determine which sort of weight bath treatment yielded the most favorable outcome. Using the participation of numerous individuals, they conducted a comprehensive analysis of the structure and movement of the spine, the impact of weight bath therapy, the distribution of force, and the alterations in stretching using an advanced underwater ultrasound technique. Contrary to traction techniques on land, the presence of buoyancy in the water during the weight bath therapy influences the stretching process. During a weight bath therapy, the buoyancy of water reduces the weight of a 70 kg human body to only 7.9 kg, with approximately 4-4.5 kg of this weight being attributed to the head that remains above the water surface. An influential element is that warm water eliminates the muscle spasms that typically occur during traction on land, allowing the muscles to rest.The researcher conducted a comprehensive analysis of the impact of weight bath treatments on individuals with varying BMI, gender, age, weight, and height (Kurutz et al., 2003).

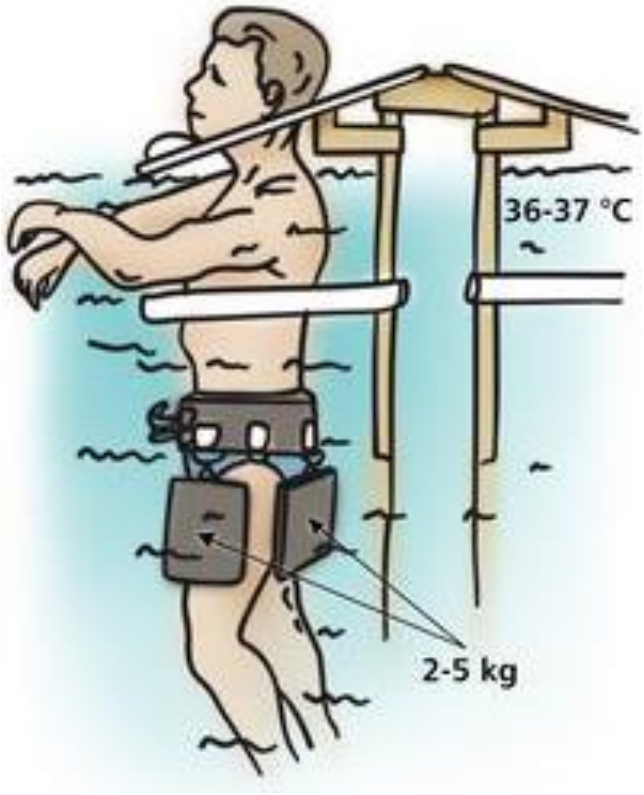


Figure 4. Schematic drawing of the first weight bath treatment in Hévíz, Hungary. Source: https://www.heviz.hu

The study aimed to identify the most effective treatment protocols and validate their biomechanical foundation. During the treatment, she regarded two vertebrae and the intervertebral disc between them as spinal segments and analyzed the alterations in these segments. According to her tests, the best beneficial outcome can be obtained by undergoing a 20-minute weight bath therapy in water that is 34 degrees Celsius. A substantial portion of the elongation takes place during the initial stage of the weight bath therapy, with an average increase of 0.4-0.6 mm per segment. This rate then rises to 1.0-1.9 mm per segment at the conclusion of the treatment. By adding more weights, it is possible to induce an additional stretching of 0.4–0.5 mm (Kurutz et al., 2002).

Applying a 20-minute therapy utilizing the patient's own weight results in a 0.7-0.9 mm extension at the lower lumbar spine. The utilization of additional weights results in an increase of these measurements from 0.8 to 1.4 millimeters. Le Blanc's research indicates that there is a projected growth of 1 mm each segment during nocturnal sleep. Underwater traction involves a comparable degree of stretching, although it happens at a much-accelerated rate compared to sleep. There are significant disparities in the biomechanics of stretching between males and females. Initially, women experience a lesser degree of stretching compared to men during the therapy. However, at the conclusion of the 20-minute session, the disparity between the stretching effects on men and women diminishes. The elasticity of the ability to stretch diminishes with age. Subsequently, the malformed, ossified, inflexible growths exhibit significantly reduced elasticity. This age-related alteration primarily impacts the lower lumbar region of the spine rather than the higher portion. The efficacy of the weight bath treatment was not significantly influenced by the patients' body weight. Following the weight bath treatment, 90% of the stretching impact diminishes promptly due to walking and standing. However, if we administer the weight bath treatment consecutively multiple times, the elongation effect persists significantly over the period spent on land after the treatment (Kurutz 2006).

Kurutz analysed the elastic elongation (strains) in individuals of varying ages. During the initial stage of the weight bath treatment, the segment experiences a stretch of 0.8 mm (10%) for patients below 40 years of age, 0.5 mm (6%) for patients between the ages of 40 and 60, and 0.2 mm (3%) for patients above 60 years of age. The ultimate elastic elongation at the conclusion of the treatment was 1.5 mm (18%) for individuals under 40 years old, 1.2 mm (15%) for those between 40-60 years old, and 0.6 mm (7%) for individuals over 60 years old per segment. The study's overall finding indicates that individuals over the age of 35 experience a loss in elongation capacity of 0.01-0.04 mm per year when subjected to the weight bath treatment. There was no discernible distinction between males and females.

During cervical spine treatment, the role of the lungs and breathing is crucial. The lungs act as a dynamic air reservoir, continually changing in size, and thus, they support the entire body by providing lift. The tensile force undergoes periodic fluctuations that synchronize with the respiratory rate. The craniocervical transition fluctuates by approximately 0.7 kg for women and 0.9 kg for males.

WEIGHT BATH TREATMENT IN EVERYDAY PRACTICE

The underwater traction treatment is conducted in a specialized pool that features a trench measuring 40x40 cm along one of its edges. If required, the patient can securely reenter the pool from the 40 cm wide trench. The pool wall adjacent to the ditch serves as the anchor for the support system that ensures traction. The suspension system employs a strap that is suspended from a chain, positioned on the mandible and occiput, and upheld by two armpits. The patients position themselves in a way that allows the warm water to reach their necks. Weight bath treatment involves the use of a head collar, and two armpit supports. Depending on these factors, the suspension can be either one-point, two-point, or three-point (Figs. 5, 6, and 7) The benefit of weight bath treatment, in contrast to land traction, is the absence of obstacles that impede the treatment, such as friction, the weight of the reclining or seated body, and reflex muscle resistance. The weight bath treatment is mostly employed for degenerative spine conditions and is also utilized for knee and hip joint contractures. During the weight bath treatment, a customized therapy can be developed for the patient based on their complaints, radiological results, and clinical symptoms. This can be achieved by employing various suspension techniques and optionally incorporating additional weights.

With single-point suspension, the neck region experiences the highest traction force, while with two-point suspension, the distal segments of the spine experience the largest extension force

Figure 5. Weight bath treatment unit. Photo: Cs. Oláh

Figure 6. Weight bath treatment. Photo: Cs. Oláh

(Gáti et al., 2020; Oláh et al., 2008) The implementation of the three-point suspension enhances the efficacy of lumbar extension, while reducing the cervical strain. The force generated by the body's own weight is deemed adequate for treating the cervical spine. However, additional weights are typically employed when treating the lumbar segment, hip, and knee joints. The weights typically range from 2x2 to 2x4 kg, catering to individuals of varying body weights and musculature, regardless of gender. Usually, the underwater traction therapy commences by utilizing the patient's own body weight, without the inclusion of additional weights. When there are complaints specifically related to the cervical spine, a one-point suspension is used. For lesions affecting the thoracic and lumbar regions, a two-point suspension is employed. In cases where all three spinal segments are affected, a three-point suspension with armpit support is necessary. When applying traction to the cervical spine, we initiate the process by utilizing the three-point suspension. If you are already executing the suspension in a secure and complaint-free manner, then you may utilize the one-point suspension. The initial duration of the average treatment is 10 minutes, followed by a subsequent duration of 15-20 minutes.

Figure 7. Group weight bath treatment pool Photo: Cs. Oláh

Figure 8. Sagittal MRI- lumbal disc herniation
Photo: Cs. Oláh

The purpose of the weight bath treatment:

- decompression of the spinal canal and nerve root canals
- temporary reduction of pressure inside the discs
- reduction and elimination of disc herniations and protrusions

- expansion of foramen, reduction, or elimination of compression of nerve roots
- reduction of tension in spinal muscles, ligaments, and tendons
- elimination of small joint blocks, elimination of small joint pain
- reduction of ligament and muscle contractions.

The essence of the underwater traction procedure is that the vertebrae move away from each other, thereby reducing the pressure in the nucleus pulposus, a presumed improvement method, that the disc protrusions, hernias or small joint displacements settle. As a result of the treatment, the tension of the spinal ligaments and muscles is reduced, the physiological curves of the spine are straightened, the root canals expand, and the nervous systems "breathe". The weight bath treatment is used only in the case of pain of spinal origin, it is also used partially in the case of radicular pain or in the case of both pains occurring together. It is also suitable for eliminating small joint pain.

Indications for the weight bath treatment:

- low back pain, cervical pain
- cervicobrachialgia, sciatica
- disc herniation disc protrusion, bulging disc (Figs. 8, 9)
- spondylosis, spondylarthrosis
- stenosis canalis spinalis
- intercostal neuralgia, occipital neuralgia
- hip arthrosis, knee arthrosis.

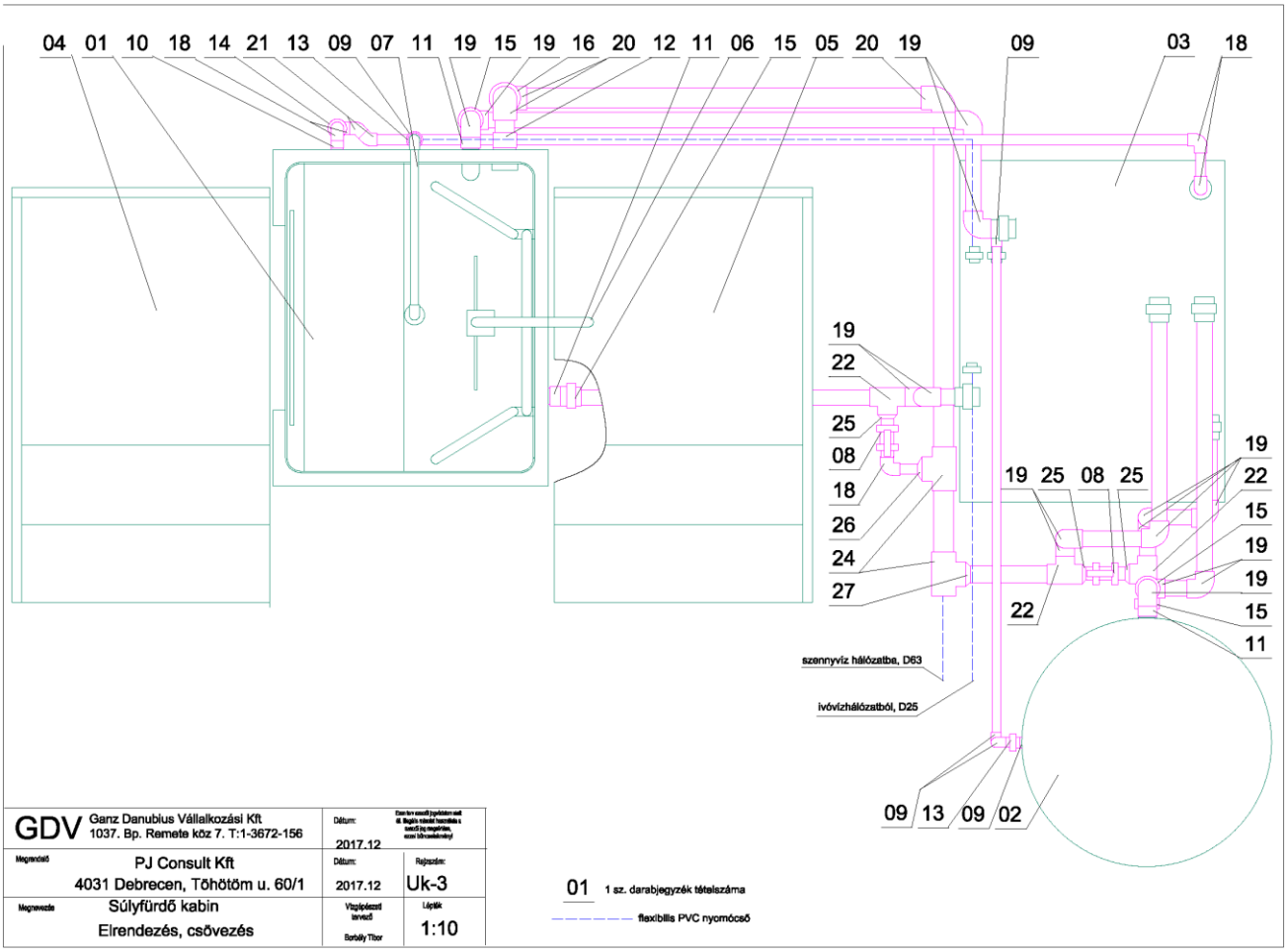
Figure 9. Sagittal MRI- cervical disc herniation.
Photo: Cs. Oláh

The contraindications for the weight bath treatment somewhat overlap with those of balneotherapy. These include angina pectoris, hypertension, hyperthyroidism, cor pulmonare, cardiac decompensation, and asthma cardiale. Underwater traction therapy is contraindicated for individuals with incontinence, a feverish condition, tuberculosis, osteomyelitis, infectious disease, acute stage of locomotor diseases, multiple sclerosis, or dystrophia musculorum progressiva. Contraindications include severe liver and kidney disease, arteriosclerosis, mental disorder, and malignant tumor. Spine diseases such as radiculitis, spondylolysis, spondylolisthesis, spondylitis, TB, primary vertebral tumor, vertebral metastases, spine surgery, vertebral fracture, severe osteoporosis, and ruptured disc herniation are circumstances that make weight bath treatment unsuitable (Borodulina et al., 2022).

Multiple clinical investigations have validated the effectiveness of weight bath therapy. In 1963, Domonkos and Szabó presented their findings in Szeged. They discovered that when half of the patients with lumbar discopathy underwent weight bath treatment, they experienced complete relief from symptoms, while 45% showed improvement. Similarly, 36% of patients with cervical discopathy achieved symptom-free status. 60% of them showed improvement. Out of the extensive clinical trials conducted by Moll, 76% of individuals suffering from lumboschialgia experienced complete relief from symptoms, while 21% demonstrated noticeable therapeutic improvement. None of the tests indicate any signs of clinical worsening. Konrád verified that the weight bath treatment had a significant analgesic and mobility-enhancing impact. In a pilot control group follow-up clinical study (Oláh, M.) confirmed that as a result of the weight bath treatment, the reduction of spine and root pain, range of motion and many components of quality of life in patients with cervical and lumbar disc herniation improved significantly more than those who only received iontophoresis and McKenzie exercises. The favourable clinical effect persisted after 3 months.

BALNEOTHERAPY

Balneotherapy means treatment with medicinal waters. Medicinal waters can be used very effectively in the prevention, treatment, and rehabilitation of many somatic and psychosomatic diseases (Bender et al., 2013). The effect of medicinal waters was previously confirmed both empirically and in numerous double-blind, placebo-controlled clinical trials. Clinical studies have confirmed the beneficial clinical effect of medicinal water therapy in the field of arthrosis, low back pain, psoriasis, pulmonological, dermatological, gynecological and psychosomatic diseases, chronic inflammatory gastrointestinal, endocrinological and neurological diseases. This research proved that medicinal waters have a beneficial effect on chronic back pain, osteoarthritis of the hands, gonarthrosis and coxarthrosis. As a result of the warm medicinal waters, muscle relaxation occurs, the spasm of the paraspinal muscles decreases, thus the axial pain decreases. As a result of warm medicinal waters, beta-endorphin is released, which has a direct pain-relieving effect. According to the latest clinical research, medicinal water treatments not only have a beneficial effect on our body, but also on the microbiome of our skin.



No.	Pcs	Title	Size	Material		No.	Pcs	Title	Size	Material
01	1	Cabin	Uk-4	KO		14	1	Glued straight Dutch	D32	PVC
02	1	Equalisation tank	Uk-4	PP		15	4	Glued straight Dutch	D50	PVC
03	1	Water treatment unit	Uk-7			16	1	Glued straight Dutch	D63	PVC
04	1	Patient stairs	Uk-6	KO		17	6	Glued elbow, 90°	D25	PVC
05	1	Handling stairs	Uk-6	KO		18	5	Glued elbow, 90°	D32	PVC
06	1	Suspension mount				19	14	Glued elbow, 90°	D50	PVC
07	1	Tank washing		KO		20	3	Glued elbow, 90°	D63	PVC
08	2	Glue-on ball valve	D32	PVC		21	2	Glued elbow, 45°	D32	PVC
09	2	Glued transfer node	D25-3/4"	PVC		22	3	Glued Tee-fitting	D50	PVC
10	1	Glued transfer node	D32-1"	PVC		24*	2	Glued Tee-fitting	D63	PVC
11	4	Glued transfer node	D50-1,5"	PVC		25	3	Glued reducer	D32/50	PVC
12	1	Glued transfer node	D63-2"	PVC		26	1	Glued reducer	D32/63	PVC
13	2	Glued straight Dutch	D25	PVC		27	1	Glued reducer	D50/63	PVC

Figure 11. The structure and materials of the weight bath cabin. Design: Tibor Borbély
* There is no serial number 23.

WEIGH BATH BALNEOTHERAPY CABIN

The weight bath treatment is not used almost anywhere outside of Hungary. The main reason for this is that pools suitable for special weight bath treatments are not available. In most countries, patients are used to personalized treatment. This cannot be done in pools suitable for weight bath treatment. We developed our special cabin to overcome this problem.

Figure 10. Weight bath cabin. Photo: the authors

Our weight bath cabin can be built anywhere from a few units. We have developed a weight bath cabin that is easy to install and provides individual treatment. To ensure the appropriate quality of the treatment water, a separate unit provides constant disinfection and filtration, which also ensures a constant water temperature - necessary for the treatment. We can empty and fill the cabin in a very short time (max. 5 minutes) using an expansion tank. We have designed the water treatment system (valves, piping) in such a way that it can be operated easily, even without special professional qualifications, and it is possible to fully automate it. We can also provide a special vibrating roof weight bath treatment in our cabin.

The vibration-based treatment used in a weight bath is performed with a hanging element in which a strong electromagnet vibrates (Figs. 10, 11)

Advantages of weight bath cabin:

1. we can apply all the beneficial effects of the classic weight bath treatment with perfect efficiency,
2. we can implement individual treatment with precisely adjustable water temperature, using an excellent modern water disinfection system,
3. we can also use vibration weight bath treatment, which is more effective than traditional treatment,
4. easy-to-assemble, easy-to-install system,
5. immediate water purity, perfect hygiene,
6. the beneficial effects of medicinal waters,
7. thanks to a product that is also successful on the international market, the weight bath treatment can be launched in many countries.

CONCLUSIONS

Many degenerative spine illnesses are successfully treated with traction therapy. Traction causes the discs' height to change, the disc protrusions to retract, and the nerve roots' canals to enlarge. When opposed to dry traction treatment, underwater traction treatment offers numerous benefits. Warm water's impact means we don't need to rely on muscular protection. The buoyant force makes it possible to create a very cautious traction. This is arguably the safest and most efficient traction treatment available. You can conduct a customized, secure, and effective weight bath therapy with our cutting-edge weight bath cabin. We can successfully combine traction treatment and medicinal water treatment in our weight bath cabin. Across the world, our weight bath cabin makes it simple and safe to use weight bath therapy.

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