
RADON THERAPY AND SPELEOTHERAPY IN HUNGARY

NAGY Katalin¹, KÁVÁSI Norbert², KOVÁCS Tibor³, SOMLAI János³

¹*Markhot Ferenc County Hospital, Department of Rheumatology, Eger*

²*Social Organisation for Radiological Cleanliness, Veszprém*

³*Pannon University, Institute of Radiochemistry and Radioecology, Veszprém, Hungary*

Introduction

Mankind has found remedy for its illnesses in the nature since the ancient time, and used natural sources such as thermal water and caves for healing. Initially they recognized this based on experience and later the causal relationship could be explored due to the increasingly dynamic development of sciences. Hungary is very rich in medicinal and thermal waters and caves. Some of these also contain radon. Our research team studies the role of radon in these thermal places. Radon therapy was developed at the beginning of the 20th century with the discovery of radon [1].

Radon

Radon is a colourless and odourless inert gas and its isotopes can be found in the three decay sequences occurring in the nature (table 1) [2-4].

Decay sequence	Uranium	Thorium	Actinium
Initial element and its half life	²³⁸ U 4.5 × 10 ⁹ years	²³² Th 1.41 × 10 ¹⁰ years	²³⁵ U 1.41 × 10 ¹⁰ years
Radium isotopes and its half life	²²⁶ Ra 1622 years	²²⁴ Ra 3.64 years	²²³ Ra 11.7 years
Radon progeny element and its half life	²²² Rn (radon) 3.82 days	²²⁰ Rn (thoron) 55.6 sec	²¹⁹ Rn (actinon) 3.9 sec

Table 1. Main radon specific characteristics of decay sequences [3]

Radon is an unstable element ; it does not have stable isotopes. An alpha particle is emitted during its decay. Its progeny elements are formed as a result of series of decays which are also radioactive.

Radon does not react with any chemical components of the human body. It may enter into the body through the skin and lungs and it is distributed in the bloodstream. Radon

dissolves in lipids therefore it is accumulated in the body tissues that are rich in fat e.g. in endocrine glands and neurons which are surrounded by lipid-containing coat. It remains in the body for a short period ; 50 % of the intake is eliminated within 15 to 130 minutes. Radon has low penetration power : in tissues the distance is approximately 20 μm therefore it can reach the remote part of the body by a carrier [5].

The relatively high energy transfer associated with the absorption of alpha particle triggers a series of complex reactions in the tissues. Radiolytic radicals are released and these stimulate cellular metabolism and mitochondrial energy conversion as well as the biosynthesis of enzymes and other proteins or bioactive peptides.

Radon therapy

Radon therapy is a natural cure (usually supplemented with drug treatment) and most often occurs in spas, caves, and former underground mine areas. In these areas radon is dissolved in water and/or accumulated in the air and during therapy enters into the human body through the exposure to these media, drinking-cure, thermal spa-cure or dry spa, and inhalation therapy [6].

The most literature data agree upon the analgesic activity of radon that entered into the body during the therapy [6-7]. The analgesic activity will be preserved for months after the treatments and is associated with the elevated β -endorphin levels also demonstrated by experiments ; significant elevation of β -endorphin levels was measured after radon therapy [8]. In addition to analgesic activity radon appears to enhance increased development of capillaries, increases uric acid excretion, stimulates adrenalin production, decreases DNA synthesis, enhances DNA repair mechanisms and the immune system, potentiates the activities of the defence system and the function of genital organs [7,9-11].

Indication of radon therapy : inflammatory joint and spine diseases (e.g. rheumatoid arthritis, psoriasis and psoriatic arthritis, ankylosing spondylitis), neuritis, neuralgia, degenerative spine and joint diseases [12-14].

Radon therapy is defined as a medicinal therapy where the active substance is known, however neither the dose for curative effect nor the duration of required treatment is identified. During treatments the radon dose varies significantly. Since radon is applied as a natural remedy it is never the only component but other ingredients are also present. For example in case of spa therapy : mineral components, micro- and macro-elements dissolved in water. In caves : bacterial-viral sterility of the air in the cave, the carbon dioxide content of the air in the cave which is higher than average, ions dissolved in the constantly regenerated aerosol (Mg^{2+} , Ca^{2+}), lack of rapid atmospheric fronts, electric and barometric changes, etc. In mofettas the significant levels of carbon dioxide and methane which are always present.

Radon spas

The spa culture in Hungary started to develop during the Turkish subjection. Several spas from this age has still functioned today including the Turkish Bath in Eger, and the Rudas and Lukács Bath in Budapest.

According to the national registry there are 70 functioning thermal spas in Hungary complying with the relevant and recognized criteria for medicinal water and mineral water [21]. Among them the Turkish Bath of Eger is the only one founding the spa treatment on the radon content of the water i.e. where radon therapy is performed. It is obvious from table 2 that we have springs having higher radon concentration ; however, since such waters contain other therapeutic ingredients at higher concentrations only these are considered in their application. In the Turkish Bath of Eger, the springs supplying the pools arise from directly below the spa and filling up the pools without dilution within the constant spillway system. In the pools radon-containing bubbles also come up to the surface, and in some pools the water almost sparkles because of the released gases. Water temperature is 30-31°C. Patients have the opportunity to do spa-exercise in the pool. Patient may use the Turkish Bath of Eger in a curative manner up to 2 times a year, on 15 occasions, for 30-40 minutes per occasion.

Radon concentration of the Turkish Bath of Eger is lower than that of other radon-containing springs in the world ; however, still it has therapeutic efficiency (table 2). Also, Radon-containing spring supplies Rudas Bath in Budapest that is used to fill up the pools after dilution with tap water. In the drinking hall of the spa the water of the Hungária, Attila and Juventus springs can also be consumed as a drinking-cure.

Bath name	Mean radon concentration of the spring water [Bq/dm³]
Rudas Bath, Juventus spring	135
Rudas Bath, Attila spring	289
Rudas Bath, Hungária spring	393
Rácz Bath	123
Gellért Bath III. spring	49
Gellért Bath VI. spring	104
Turkish Bath of Eger, Spring of Turkish pool	103
Taishan (China)	57
Nanshui (China)	280
Polichnitos spa (Greek)	210
Badgastein (Austria)	662
Bad Steben (Germany)	800
Bad Elster (Germany)	1300
Jachymov (Czech Republic)	4250
Misasa (Japan) (90 springs)	17-9361

Table 2. Radon concentration of waters of spas found in various countries [14-20]

Some radon can be detected in the water of Lake Hévíz but its curative effects are not likely to come from its radon content [21].

Speleotherapy

Therapeutic effect of caves has been discovered empirically. Records on medicinal caves have even originated by the men of Middle Age ; however, the first scientific studies were conducted in Germany in the 1950's.

Speleotherapy utilizes the special climate of caves for the therapy. These include constant temperature, humidity, high CO₂ level, lack of air pollution, microorganisms and allergens, and high salt content of the air. Only limited randomized, controlled studies were published on speleotherapy with contradictory results ; therefore further studies should be conducted to demonstrate efficacy of speleotherapy [22].

Based on the temperature medicinal caves can be categorized into low (e.g. Hungarian medicinal caves) and high temperature caves (e.g. Bad Gastein).

In Hungary the first speleotherapeutic activity was noticed during the discovery of the Béke cave of Aggtelek. Due to the results the first medicinal cave of Hungary was built one year after the discovery of the cave, and then speleotherapy was started in more and more cave. Today 5 medicinal caves function in Hungary. The names of the caves are listed below [23] :

- Béke Cave (Aggteleki karszt, Jósvalfő)
- Tapolca Hospital Cave (Bakony, Tapolca)
- Szemlőhegy Cave, “Óriás folyosó” (Giant Corridor) (Buda Mountains, Budapest)
- István Cave, “Fekete terem” (Black Hall) (Bükk Mountains, Miskolc-Tapolca-Lillafüred)
- Abaliget Cave, “Gyógyterem” (Medicinal Hall) (Mecsek, Abaliget)

Speleotherapy is used for the treatment of obstructive respiratory diseases (bronchitis and asthma) [24].

The hospital cave of Tapolca is available not only for the hospital's patients but the guests of the hotel connected to the cave may also use the cave.

There is measurable radon content in all Hungarian caves.

From table 3, it can be observed that the mean radon concentration per year varies within a broad range, between several hundreds and thousands of Bq/m³. If there was a relationship between the improvement of asthmatic diseases and bronchitis and radon concentration, the change in improvement rate would correlate with the change in radon levels. Studies performed by our research team in the Tapolca Hospital Cave having the most extreme radon concentrations among all medicinal caves, have not demonstrated this result [5,26]. Thus, with regard to radon concentrations in Hungarian medicinal caves and the applied therapeutic methods we cannot speak about radon therapy but only about speleotherapy.

In case of radon therapy in Hungary mofetta of Mátraderecske should be noted which officially operates as a carbon dioxide medicinal gas-bath, but in addition to 86 % CO₂ concentration there is radon content of 125 kBq/m³ in the released gas [28]. Mofetta is a

Cave	Mean radon concentrations per year (Bq/m ³) (min-max)	Duration of therapy
Béke Cave	2193 (1000-4600)*	3 weeks, 3-5 hours per day
Hospital Cave of Tapolca	4600 (530-16700)	3 weeks, 3-4 hours per day
Szemplőhegy Cave	5484 (3700-7500)*	at least 3 weeks, 3 hours per day
István Cave	708 (130-1600)*	3 weeks, 2.5 hours per day
Abaliget Cave	2689 (150-9900)*	depends on the participant, without medical supervision

* These are not the data of the “medicinal” halls but are characteristic to the expected radon concentration of the area

Table 3. Mean radon concentrations per year and therapeutic periods in the therapeutic caves [22]

low temperature volcanic discharge consisting chiefly of carbon dioxide. The therapeutic gas containing high percentage of carbon dioxide and radon in therapeutic concentration discharged from the depth of about 1000 m is particularly efficient for the treatment of arterial diseases (vascular stenosis in the extremities of various origin and severity), vascular complications of diabetes, high blood pressure, various rheumatic diseases, autoimmune diseases associated with severe vascular conditions, some gynaecological diseases, infertility and impotence problems, medicinal problems with vegetative origin.

Summary

Radon therapy is a natural treatment recognized by physicians. Research performed until now has demonstrated efficiency primarily in inflammatory rheumatologic conditions, rheumatoid arthritis and ankylosing spondylitis. It makes the judgment of radon therapy uncertain that in practice it does not occur alone as a separate active substance, and the required therapeutic dose and treatment duration is unclear.

In Hungary radon is present in various quantities in medicinal spas, therapeutic caves and the mofetta of Mátraderecske as natural therapeutic treatment.

However, specific radon therapy is available only in the Turkish Bath of Eger.

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The Turkish Bath, Eger

