

<https://doi.org/10.48047/AFJBS.6.15.2024.12348-12359>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

A morphological study of the medical leech (*Hirudo medicinalis*) and its role in treating osteoporosis

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Volume 6, Issue 15, Nov 2024

Received: 20 sep 2024

Accepted: 05 Oct 2024

Published: 05 Nov 2024

doi: [10.48047/AFJBS.6.15.2024.12348-12359](https://doi.org/10.48047/AFJBS.6.15.2024.12348-12359)

Abstract

Treatment with medical leeches has been available since ancient times and has been used for more than 2,500 years by Egyptians, Indians, Greeks and Arabs as a treatment for some specific diseases such as skin diseases, infections, etc. Medical leeches provide medical benefits by absorbing blood and delivering many biologically active substances. Recently, this technology has reached the widest field of application, so we focused on medical leeches from a morphological standpoint, as they are blood-sucking worms that live in fresh water. Their bodies are divided into rings and they have two suckers, anterior at the front of the body and posterior at the end.

On the other hand, we discussed the role of medical leeches To handle a case of some diseases, for example, osteoporosis, due to the various active substances contained in its saliva. The results showed a significant improvement in the patient's health condition.

Keywords: osteoporosis, medical leeches, Patients.

1. Introduction

Over several thousand years, different medical cultures have been making use of treatment with leeches. In the 17th and 18th centuries (Stang et al., 2012), Leeches and the legends surrounding their usage in medicine have been inexorably attached to the physician. The very origin of the word leech may be taken from the old English laece meaning physician (Stephen et al., 1988).

Medical leeches are considered one of the most important invertebrate animals that belong to the annelid phylum, which falls within the three-layered true coelomates, hermaphrodites (Mohamed, 2010).

Leech saliva contains an anaesthetic so that patients do not feel the bite. In addition the saliva has a chemical preventing blood clotting. However there may be occasions such as cold skin, smoking or age related issues that may affect the anaesthetic qualities of a leech bite. This can be resolved by warming and cleaning the skin (Snigh, 2010).

Medical leeches are the most important type in Hairless type. They primarily inhabit freshwater environments, where they function as fluid-feeding ectoparasites on vertebrate hosts or act as predators and scavengers of freshwater invertebrates (Iyer et al., 2019). It belongs to the Hirudinida family. More than 650 species of leeches have been identified around the world, but only 15 species have been classified as medical leeches, and the most famous of them used in modern medicine is *Hirudo medicinalis* (Linné, 1758).

The color of medical leeches is between dark brown and green, and the size of the largest one reaches 45 cm. The morphology of the medical leech contains a true division but lacks suffixes. It has a high ability to absorb blood and can ingest more than six times its body weight in a single blood meal (Indergand et al., 2000). Medical leeches are of great importance in the medical field, as they are used in the treatment of many diseases and also in the manufacture of anticoagulant drugs. This is thanks to the substance hirudin, the prominent component in its saliva (Boughalmi et al., 2013), in addition to other substances of promised medical importance and value in the field of pharmaceutical industrial production, among these diseases musculoskeletal and osteoporosis. These substances have analgesic, anti-inflammatory and anticoagulant effects, as they affect an important blood mechanism, which is hemostasis. The aim of our work is to study medical leeches from a morphological perspective and use them in the treatment of osteoporosis.

Keywords: osteoporosis, medical leeches, *Hirudo medicinalis*.

2. Material and methods

2.1. Buy medical leeches

Purchase price: between 250 Algerian dinars and 300 Algerian dinars per leech, equivalent to between 1 and 1.2 euros.

- Where to buy it: from Bouira state

- Buy leeches ready-made from trusted specialists because collecting wild leeches from natural environments for medical use can be problematic due to the risk of transmitting microorganisms (Boughalmi et al., 2013).

2.2. Conditions for keeping leeches

a) Temperature:

- Leeches are stored at a cold temperature 22–23 °C (De Eguileor, 2001)
- In the summer, when the temperature is high, place the jar of leeches in a room with air conditioning or in the refrigerator.
- Avoid large differences between the temperature of the water in which the leeches are placed and the water that the breeder will replace for them so as not to cause them a thermal shock.

b) Lighting:

Leeches are placed in normal lighting conditions, whether natural, artificial, or in the dark. They prefer dark places, while avoiding placing them in direct intense lighting, such as direct sunlight.

c) Suitable bottle:

Leeches can be stored in containers, plastic bottles, or glass jars, while providing good ventilation by making holes in the lid of the plastic bottle. These holes should be small to prevent the leeches from coming out. To avoid this, it is best to close the bottle with a cloth and secure it tightly with a rubber band.

3. Morphological study of medical leeches (*Hirudo medicinalis*)

To conduct a morphological study of the medical leech (*Hirudo medicinalis*), we measured some biometric parameters such as length and weight and took real photographs of adult medical leeches at the zoology laboratory in Higher Normal School of Technological Education- Skikda.

4. Treatment method

We accomplished this work at the level of the Healing Hand Center for Physical Care located in the municipality of Azzaba, Skikda Province, under the supervision of specialist Ben Redouane M.

This work was completed during the period from March 2023 to April 2024. The total number of patients suffering from osteoporosis who were treated with medical leeches was eight patients.

In this study, we focus on one of them, examining his treatment and results, Patients share a set of symptoms, the most important of which are constant pain and stiffness in the lower

back, as well as difficulty walking and standing for long periods, and pain when bending over. In addition, the patients underwent x-rays, where doctors confirmed osteoporosis.

Before starting the treatment process, the therapist first provided a definition of treatment with leeches and information about how to apply it and its benefits because most people are afraid of treatment, and view leeches as a disgusting, harmful animal, and are afraid to see this sticky worm applied to the skin.

The patient was also informed that there was no pain during the application of the leeches, except for a slight sting due to the sting, and the therapist learned about the patient's health condition and the diseases he suffers from. After the patient's approval, the treatment period is divided into three sessions, with the duration between each session being a week.

4.1. Before each session

- Provide the patient with a rest period of about 10 minutes.
- Measure blood pressure
- Measuring the patient's temperature, as it is an important factor in promoting the expansion of blood vessels and thus stimulates the leeches to bite. The optimal temperature ranges between 33-40 degrees Celsius.
- Start by cleaning the area affected by leech treatment from bacteria and sweat by washing it well with water.
- Clean the area with Dacan solution

4.2. Stimulating leeches to bite

The first factor that stimulates biting is starving the leech before using it.

If the leech does not bite, it is fixed by closing it using a cupping cup in the desired area until it sticks

.In other cases, the area is pricked with a needle until a drop of blood comes out to stimulate the leech, and if there is no reaction, the leech is replaced with another.

4.3. The treatment sessions

- **The first session:** 4 leeches were applied to the areas that caused the most pain when pressed



Figure 08 : A picture showing the first session of treatment, July-2023

- **The second session:** 4 leeches were applied



Figure 09 : A picture showing the second session of treatment, July-2023

- **The third session:** 3 leeches were applied



Figure 10 : A picture showing the third session of treatment, July-2023

- **Leech separation:**

After the leech attaches to the desired area of the skin, it feeds for 30-90 minutes and then separates automatically once the meal is over.

4.4. After the medical leech session

First, check for the presence of a bite wound: to ensure that the leech has done its job, then the therapist cleans and sterilizes the place with Dakin solution or hydrogen peroxide, and places a bandage on the wound.

4.5. Among the tips given to the patient after the leech session

- Do not shower on the day of treatment.
- Avoid eating dairy products and derivatives.
- It is also recommended to avoid smoking



Figure 11 : A picture of a leech bite scar, July-2023

4.6. Disposal of used leeches

Leeches have only one use and should not be released into the wild after using them. They must be killed by putting them in table salt, which leads to their death because they are considered infectious **biological waste**.

5- Results and discussion

5.1. Morphological study

a) The shape :

Leeches are symmetrical laterally and have a body covered with skin that does not contain motor appendages. It has several shapes, the most important of which is long cylindrical.



Figure 01: A picture of a medical leech (*Hirudo Medicinalis*), may-2023

b) The color :

The color of medical leeches is between dark brown and green, and it varies from one type to another. On the basis of this, a distinction is made between its four types, which are:

Hirudo Torctina

Hirudo Verbena

Hirudo Orientalis

Hirudo Medicinalis.

It should be noted that in this study we relied on the species : *Hirudo medicinalis*

The dorsal surface of the body is olive green or brown, and the abdomen is pale yellow and large in size with a number of irregular black spots.

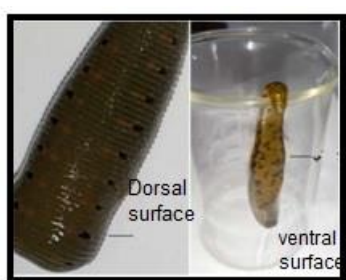


Figure 02 : Picture of dorsal and ventral surface of leech, May-2023

c) The size :

The size of the animal varies according to the type, temperature, and leech activity, as it has different dimensions:

- When the leech is shrunken, that is, in the form of an olive, its length ranges from 5 to 10 centimeters and its width is 1.5 centimeters.
- At a temperature of 4 degrees Celsius, the leech is inactive, its length is 3 cm and its width is 1 cm
- At room temperature and during a blood meal, the leech takes on the appearance of a rectangular strip and can reach 12 centimeters in length and 3 centimeters in width.
- The weight of an adult medical leech is about 2 to 3 grams on an empty stomach and reaches about 5 grams after eating.



Figure 03 : A picture of a hungry leech and another after eating, May-2023

d) The Metameres :

- Medical leech has a fixed number of metameres, which is 33 metameres.
- Each metamere is divided externally into a number of rings, the total number of which reaches 105 rings.
- Each metamere is divided into 5 rings, except at the two ends of the body, where the number of rings is less.
- The posterior seven metameres are transformed into posterior sucker.

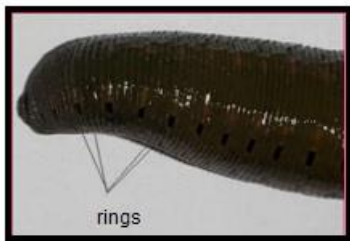


Figure 04 : A picture that illustrates the metameres (rings), May-2023

e) Suckers :

Leeches have two suckers, each at one end of its body, an anterior sucker and a posterior sucker.

- *The anterior sucker :*

The anterior sucker has a hole in it, which is the mouth opening

- It is used to suck blood
- It contains two or three pairs of chitinous jaws. The sides of these jaws form an angle of 120 degrees, forming a V or Y-shaped slit in the skin



Figure 05 : The anterior sucker

- *The posterior sucker:*

It is also called the peripheral sucker. It is not perforated and is larger in size than the anterior one. It is used for movement and adhesion.



Figure 06 : The posterior sucker, May-2023

f) The Eyes :

The leech has 5 pairs of pigmented cup eyes, which it uses to detect shadows. The eyes are embedded in the skin in the dorsal region of the head.



Figure 07 : The distribution of eyes in medical leeches, May-2023

5.2. Treatment

During the entire study period, it was observed that pain and spasm began to decrease after the first session of leech treatment and after the last follow-up, there was a significant reduction in symptoms including pain and stiffness in the lower back and a significant improvement in standing, movement and walking with the disappearance of pain when

bending. A leech bite scar has also been observed at the site of the bite but it becomes less noticeable within 2-3 weeks after the last leech treatment session. Sometimes, itching is also observed and subsides 2-3 hours after the leech is removed. Bleeding at the site of the bite for more than one hour has also been observed in a few cases.

In our work, we used the medicinal leech of the type (*Hirudo medicinalis*). After studying it morphologically, we tried to use it in treating osteoporosis and determining the degree of improvement in patients. It became clear that this improvement is due to:

The morphological results we obtained are largely consistent with the results of Saglam, N et al 2008, where the study conducted by him proved that medical leeches have flat bodies on the dorsal and ventral sides, containing two suckers, one front and one back. Their body length is from 10 to 15 cm, and the weight of adult leeches is from 3 to 6.3 grams (Saglam, 2008)

-The mechanism of action appears to be the secretion of biologically active substances from the salivary glands of the leech onto living organisms. There are 100 different of bioactive materials in leech saliva. The most common found is hirudin, a substance which oppresses the process of blood clotting. Secretions from the leeches salivary glands also contain anti-inflammatory, bacteriostatic, and analgesic actions. These eliminate micro-circulation disorders and, restore the damaged vascular permeability of tissues and organs, eliminate hypoxia, reduce blood pressure, increase immunity, increase the bioenergetic status of the organism (Snigh, 2010)

-The mechanism of oppressing thrombin, blocks the action of thrombin and the transition of fibrinogen into fibrin. Secretions from the salivary glands of medicinal leeches also block the attachment of thrombocytes and this completely suppresses their aggregation on the surface of collagen. Thus, medicinal leeches saliva secretions has a direct influence.

-Treatment with leeches is considered an effective treatment, as leeches are used and their ability to absorb blood and inject effective and beneficial substances for humans.

The various bioactive substances in leech saliva may also be as pharmacologically potent as hirudin and thus exert substantial effects in peri-articular tissue and adjacent structures. (Michalsen et al., 2003)

The results we obtained in our work are largely consistent with the results obtained by the scientist in Michalsen Andreas 2002, where he treated 16 patients aged between 9 and 69 years with osteoarthritis of the knee. 10 patients were treated with leeches and 6 of them served as controls. The results were as follows: Applying 4 leeches around the affected joint led to rapid pain relief with continuous improvement after 4 weeks in the absence of side effects. Treatment with medical leeches was widely accepted by all patients who were treated.(Michalsen et al., 2002)

In 2018, Haixia Wang et al evaluated the efficacy and safety of medical leech therapy in 264 patients with knee osteoporosis. The result was a significant improvement in terms of pain relief and functional recovery of patients (Wang et al., 2018)

Not only in treating osteoporosis, but leeches have also proven their effectiveness in addressing other diseases, like laryngitis, ophthalmic problems, cerebral apoplexy, obesity, and mental disorders (Maetz et al., 2019) blood pressure (Saglam, 2008), plastic and reconstructive surgery (Ceylan et al., 2015).

Finally, the scientist Andereya and others (2008) confirmed the role of medical leeches in treating patients with osteoarthritis of the knee, where he treated 113 patients and observed a significant improvement in the patients.(Andereya et al., 2008)

6. Conclusion

The medical leech is distinguished by its morphological structure, as the latter's body is composed of 34 interconnected rings, its height is about 20 cm, and its color is greenish-brown or greyish-black. It sucks blood, as it has two suckers at each end: the anterior sucker and the posterior sucker. This type Lives in fresh water. They have an effective role in treating osteoporosis due to the substances found in their saliva. These substances have analgesic, anti-inflammatory and anticoagulant effects, as they affect an important blood mechanism, which is hemostasis.

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