

## Medicinal leech therapy in pain syndromes: a narrative review

Detlev Koeppen · Michael Aurich · Thomas Rammpp

Received: 25 January 2013 / Accepted: 5 August 2013  
© Springer-Verlag Wien 2013

**Summary** Medicinal leech therapy is used in a variety of conditions; most of which have pain as a major symptom. Its mode of action relies on the injection of leech saliva into patients' tissues during the process of blood withdrawal. Leech saliva contains active ingredients with anti-inflammatory, thrombolytic, anti-coagulant and blood- and lymph-circulation enhancing properties. A specific analgesic substance within the leech saliva is yet to be identified. Pain relief from leech therapy is rapid, effective and long-lasting in many conditions. This review compiles studies and case reports that provide clinical evidence for leech therapy's analgesic effects.

**Keywords** Leech therapy · Hirudotherapy · Pain treatment

### Schmerztherapie mit medizinischen Blutegeln – Eine zusammenfassende Übersicht

**Zusammenfassung** Die medizinische Blutegeltherapie wird in einer Vielzahl von Indikationen angewendet, sehr häufig zur Behandlung der Schmerzsymptomatik. Der Wirkmechanismus der Blutegeltherapie beruht vor allem in der sekretorischen Abgabe von Wirkstoffen im Verlauf des Saugvorgangs. Dieses Sekret enthält Substanzen mit anti-entzündlicher, thrombolytischer, gerinnungshemmender sowie Blut- und Lymphkreislauf anregender Wirkung. Eine spezifisch analgetisch wirksame Substanz konnte bisher nicht identifiziert werden. Dennoch zeigt sich in einer Vielzahl klinischer Anwendungen der Blutegeltherapie eine rasch eintretende und lange wirksame Schmerzlinderung. Die folgende Übersicht fasst die Ergebnisse klinischer Studien und Fallberichte zusammen, die auf die analgetische Wirkung der medizinischen Blutegeltherapie hinweisen.

**Schlüsselwörter** Blutegeltherapie · Hirudotherapie · Schmerztherapie

---

T. Rammpp, MD (✉)  
Department of Internal and Integrative Medicine,  
Kliniken Essen-Mitte, Am Deimelsberg 34a,  
45276 Essen, Germany  
e-mail: t.rammpp@kliniken-essen-mitte.de

D. Koeppen, PhD  
Biebertaler Blutegelzucht GmbH,  
Talweg 31, 35444 Biebertal, Germany  
e-mail: koeppen@blutegel.de

M. Aurich, MSc biol  
Biebertaler Blutegelzucht GmbH,  
Talweg 31, 35444 Biebertal, Germany  
e-mail: aurich@blutegel.de

T. Rammpp, MD  
Faculty of Medicine, University Duisburg-Essen,  
Am Deimelsberg 34a, 45276 Essen, Germany

### Introduction

Leech therapy has a long and widespread tradition, as pharaonic tomb paintings (1500 BC), Sanskrit writings (1300 BC) and classical Greco-Roman reports testify [1–3]. In medieval England, the term 'leecher' was used synonymously with 'healer'. By the mid nineteenth century, leeching had become so popular, especially in France, that it nearly eradicated leeches' natural sources. In its heyday, leeching was a popular form of therapy, used by ordinary people as well as by prominent citizens, such as George Washington and Napoleon Bonaparte, alike. Although leech therapy's use declined to near

oblivion in Western society, in the interim, it has enjoyed an impressive resurgence in popularity since the 1970s.

In Europe, three species of medicinal leeches exist in the wild: *Hirudo verbana*, *Hirudo medicinalis* and *Hirudo orientalis* [4], with *Hirudo verbana* being the most common. *Hirudo verbana* is found in river deltas and reservoirs in Turkey, Romania and Serbia or as small scattered populations in Northern Europe.

Leech therapy has only recently been approved as a legal therapeutic intervention in Europe, with Germany having the most extensive legal guidelines in this area to date. The German Health Authority, which began the leech therapy approval process in 2005, published its legal guidelines in 2007 [5]. These guidelines improve leech therapy's safety significantly, mandating that medicinal leeches be supplied only by companies with pharmaceutical manufacturing authorization. Germany's pioneering role in this area appears linked to its dominance of the European leech market, with approximately 100,000 leech sessions corresponding to about 350,000 leeches used in Germany annually.

## Materials and methods

The literature search for this review was conducted using the PubMed/Medline database, as well as Google Scholar and Current Contents Med. It included randomised controlled studies, uncontrolled studies and descriptive case reports; focusing on results from studies that used well-established quantitative pain measurement instruments.

## Suggested mode of action of leech therapy

Blood withdrawal during leech therapy is of prime importance in only a minority of indications, such as the treatment of haematoma. In most cases, the essential principle of action is the injection of active ingredients in the leech saliva into patients' tissues during the blood withdrawal process. Research shows that leech saliva contains mainly peptides and proteins, as well as further small organic molecules [6]; a total of 100–200 suspected substances [7, 8]. The structure of only a few of these substances has been identified to date [9, 10].

In a recent review article [6], a number of major components of leech saliva including histamine, serotonin, steroid hormones and modulators, enzymes, protease inhibitors and anti-microbial agents were noted. These substances have anti-coagulant and blood circulation enhancing effects (e.g., hirudin, Factor Xa inhibitor, calin); thrombolytic (e.g., destabilase); vasodilatory (e.g., hyaluronidase) or anti-inflammatory (e.g., bdelins, eglins, antistasin, leech-derived tryptase inhibitor [LDTI]) actions. Although a specific analgesic substance has yet to be found, clinical experience strongly supports its existence. In this context, the aphorism 'absence of evidence is not evidence of absence' seems apt.

The potential presence or absence of analgesic or anaesthetic substances in leech saliva has been debated for many years [11, 12]. Leech bites are not as painful as other types of comparable wounds, suggesting that an antagonistic painkilling agent is delivered during the biting process.

Most patients compare the initial leech sucking process to the experience of insect bites or stinging nettle pain, if any sensation is felt at all. Any unpleasant sensations felt, during leech application, usually wear off soon after biting starts.

Leech saliva ingredients appear to block certain steps of the regular pain evolving cascade by counteracting cytokines with anti-inflammatory agents in the saliva, thus triggering the analgesic action [6]. Various saliva substances show protease-inhibiting effects; counteracting the inflammatory effects of cytokines as potent sensitizers or activators of pain sensations. These substances also cleave and inactivate pain-inducing tissue cytokines. In similar fashion, eglin C inhibits neutrophil activity, inhibiting inflammation, and leech-derived tryptase inhibitor appears to suppress mast cell-mediated inflammatory reactions.

As Hildebrandt and Lemke [6] note 'leeches' must 'suppress the normal reactions of the host to such injuries (swelling, pain, inflammation) to remain undetected during the feeding process' (p. 995). This principle is also used by ticks, and other insects, when they bite.

In leech application, any pain protective action is short-lived, with most people experiencing unpleasant itching sensations, slight swelling and signs of inflammation (skin reddening) at the bite site for some days. It is during this period, that the therapeutic effects of pain relief are expected to start.

## Clinical evidence of analgesic efficacy in medicinal leech therapy

The analgesic action of leech therapy has been documented in both controlled and uncontrolled trials, as well as in case reports, for patients with pain as a prominent part of widely varied clinical conditions.

**Table 1** Pain rating scale Western Ontario and McMaster Universities (WOMAC). Subscales for the measurement of osteoarthritis pain.

Walking	0	1	2	3	4
Stair climbing	0	1	2	3	4
Nocturnal	0	1	2	3	4
Rest	0	1	2	3	4
Weight bearing	0	1	2	3	4

Severity measures can be obtained by the Likert-type scale type (e.g., 0–4), or by visual analogue scales (0–100 mm) for each item  
0 none, 1 slight, 2 moderate, 3 very, 4 extreme

## Osteoarthritis

Michalsen et al. [13, 14] conducted a non-randomised controlled pilot study of leech therapy's impact as an adjunctive treatment in 16 patients hospitalised for 2 weeks with osteoarthritic knee pain of at least 6 months' duration. Ten of these patients underwent a single leech therapy application in addition to their conventional treatment. The remaining six, control patients received solely the conventional treatment. Comparing the two groups showed that leech therapy induced more rapid pain relief (measured by a Visual Analogue Scale [VAS]) within 3 days post-application, with clinically relevant and significantly superior improvements persisting after 4 weeks. No serious adverse reactions were observed.

These results were reassessed later by the authors in a randomised controlled trial [15]. This study compared a single administration of leech therapy to the continuous use over 1 month of a standard analgesic medication (topical diclofenac) in 51 patients with osteoarthritis of the knee. Patients' pain scores on the Western Ontario and McMaster Universities (WOMAC) Arthritis Index [16] (s. Table 1) showed superior pain relief from leech therapy on all outcome measurements over 3 months, with highly significant differences in the first treatment week.

The analgesic rescue medication used in this study made no statistically significant difference to this outcome. Most of the leech therapy patients (17/24) reported itching at the bite sites and two patients experienced localised burning sensations. One patient each reported one of the following symptoms; dizziness, a local cutaneous reaction or prolonged bleeding from the bite site. Two control patients reported cutaneous tingling, with one patient each citing local burning sensations, skin reactions or abdominal complaints.

Another randomised controlled trial [17] compared single and repeated (after 1 month patients not responding to a first leech application) leech administrations in 113 patients with osteoarthritis of the knee to a sham (artificial leech) control. The study observation period was 6 months. The pain measures used (WOMAC, Knee Injury and Osteoarthritis Outcome Score (KOOS) [18] and the VAS with 0, representing no pain to 10, the worst possible pain) showed that all study groups improved, but statistically significant differences occurred only in the leech therapy groups. Patients' use of pain medication was also statistically significantly lower in the two leech treatment groups than in the control group. The greatest improvements and long-term effects were seen after 1 month in patients who had repeated leech applications. The only side effects of the leech therapy were transient local skin reactions with itching ( $N=39/73$  patients) and post-application bleeding that required bandaging, in two patients.

In a third randomised controlled trial 40 patients with osteoarthritis of the knee underwent a single application of leech therapy; or a therapeutically irrelevant single application of transcutaneous electrical nerve stimulation (TENS) as sham control [19]. Patients' treatments

were changed every 6 weeks, with a consecutive follow-up period of 3 weeks, using a cross-over design. Participants' pain scores on the Lequesne Index [20] showed highly significant pain reductions over time in the leech treatment group, in contrast to the TENS controls. The leech therapy patients reported mild local skin itching as the sole adverse reaction.

A meta-analysis that included the above studies of osteoarthritic knee pain [13–15, 17, 19] found strong evidence of leech therapy's immediate and short-term analgesic effects, as well as moderate evidence of longer-term benefits [21].

In addition to the above, other studies of leech therapy have been conducted in the context of Indian traditional medicine.

For example, Abbas Zaidi et al. [22] combined leech therapy with a traditional Ayurvedic herbal formulation (a powder consisting of *Cholchicum luteum*/Tanacetum umbelliferum/*Withania somnifera* and a *Cholchicum luteum* oil for twice daily local application), comparing this to the use of the herbal medication alone, in a total of 40 patients with osteoarthritic knee pain. The herbal medication was given continuously for 6 weeks to all patients, with additional leeching performed in one group at baseline and again after weeks 2 and 4. In week 6, use of the WOMAC pain score showed a 29% decrease in pain in the leech therapy/herbal medication group ( $N=20$ ), as compared to 14% in the mono-therapy herbal medication group ( $N=20$ ). However, the pain reduction in both groups did not differ significantly. The only side effect was mild itching at the bite site, reported by 55% of the patients who received the leech applications.

A descriptive study by Rai et al. [23] explored the effects of a single leech therapy session in patients with knee osteoarthritis. The results showed a significant decrease in patients' pain values, measured on a VAS, 6 weeks post-treatment. Local skin itching and prolonged bleeding, as well as scars at the bite site for 2–3 weeks, were cited as adverse reactions to the leech therapy.

Two further studies included an undisclosed number of patients with osteoarthritis of the knee [24, 25]. These patients underwent six, weekly, leech sessions. The pain outcome measure used in both studies (VAS) showed a statistically significant level of pain relief during the course of the leech treatments. No adverse reactions were cited.

Shiffa et al. [26] also compared leech therapy combined with applications of the same twice daily local traditional Ayurvedic herbal formulation, to use of the latter alone, in 60 patients with osteoarthritic knee pain. In this study, the leech therapy sessions were delivered weekly for 1 month. Patients' pain measurements (KOOS Scale, VAS) showed statistically significant stronger effects from the combined approach than the Ayurveda mono-therapy alone, for at least 2 months. Mild local itching at the leech bite site was reported as the sole adverse reaction by 17% ( $N=30$ ) of the Ayurveda/leech therapy patients.

**Table 2** Pain measurements in knee osteoarthritis patients undergoing leech therapy

Reference	Pain measurement instrument	Outcome
Michalsen et al. [13, 14]	Visual analogue scale	Leech therapy showed superior ( $p < 0.05$ ) pain relief as compared to control from day 3 onwards
Michalsen et al. [15]	WOMAC pain score	Leech therapy showed superior ( $p < 0.001$ ) pain relief as compared to topical diclofenac, most pronounced at day 3 and slightly diminishing over time
Andereya et al. [17]	WOMAC pain score, KOOS pain score, visual analogue scale	Leech therapy groups (single and repeated treatment) showed statistically significant pain reductions over time in contrast to the control group
Stange et al. [19]	Lequesne index	Leech therapy showed superior pain reductions as compared to TENS therapy at all rating sessions ( $p < 0.001$ – $0.007$ )
Abbas Zaidi et al. [22]	WOMAC pain score	Leech therapy in combination with an Ayurveda herbal formulation showed a more pronounced decrease in pain, but no significant differences to the herbal formulation alone
Rai et al. [23]	Visual analogue scale	Leech therapy showed significant ( $p < 0.001$ ) decreases of pain scores during the 6 weeks following the single application session
Kumar and Prakash [24, 25]	Visual analogue scale	Leech therapy showed significant ( $p < 0.001$ ) decreases of pain scores in the course of 6 weekly sessions
Shiffa et al. [26]	KOOS pain score, visual analogue scale	Leech therapy in combination with an Ayurveda herbal formulation showed significantly superior pain reductions after 4 weeks ( $p < 0.0002$ ) and 8 weeks ( $p < 0.0001$ ) in the KOOS pain score and in the visual analogue scale pain ratings (week 4 and 8: $p < 0.0001$ )

Table 2 summarizes the clinical studies in knee osteoarthritis using pain scales for the measurement of leech therapy's efficacy.

Teut and Warning [27] described the case of an elderly woman with osteoarthritis in her knees. This patient had not responded well to varied analgesics, including opiates, citing side effects such as dizziness and nausea. She was unable to walk on admission to hospital, because of pain. Following admission, she underwent one leech therapy session. Three days later, her pain had declined to the extent that she was able to begin physiotherapy exercises. Additional analgesic medication (Metamizol) further improved her condition. In their discussion, the authors emphasised the timing of the crucial improvements that occurred in this patient's condition, noting that they had followed the introduction of the leech therapy. No adverse reactions were reported.

A large observational study of 400 patients with osteoarthritis of the knee also showed the effectiveness of leech therapy's pain-reducing effects, with such relief lasting for 6–12 months, or more, in half of these patients [28]. Accordingly, it is recommended to perform biannual leech sessions for the long-term treatment of many patients with pain from joint disease. The authors cited local itching as a major adverse reaction in this study, also expressing concern about leech therapy as a potential allergen.

Another clinical study compared the effects of a single leech therapy session with topical diclofenac application twice daily for a month in 32 women with osteoarthritis of the thumb [29]. The researchers, using a 100 mm VAS, measured patients' pain at rest, on motion and on gripping. Patients' pain scores showed a significant group difference under all three conditions, in favour of the leech therapy treatments, from Day 7 onwards. This difference lasted until the end of the rating period on Day 30. No serious adverse events were cited. In all 13 of the 16 leech therapy patients reported mild local itching

and skin reddening, emerging 2–3 days post-leech application; effects that lasted some four days. In the diclofenac group, five patients also reported mild local skin reactions.

A questionnaire survey, based on 171 reports, also linked the use of leech therapy in German patients to pain relief and/or reductions in patients' use of analgesic medications in various forms of arthritis [30].

The handbook by Michalsen and Roth [10] cited leech therapy's value in reducing arthritic shoulder and ankle pain; echoing Müller's [31] recommendations that it can be used for various forms of arthritis and related inflammatory joint conditions. The authors went on to outline leech saliva's potential action on joint support structures, such as tendons, muscles and ligaments. Leech saliva may also initiate beneficial secondary changes in peri-articular connective tissues, in line with the targets of physiotherapy techniques like thermotherapy or massage. By enhancing blood and lymphatic drainage, leech saliva may also induce local tissue decongestion, leading to further potentially therapeutic effects.

Clinical evidence suggests that leech therapy can greatly reduce the pain of patients with osteoarthritis. This reduction may, in turn, set the stage for physiotherapeutic interventions that would otherwise be prevented by pain and/or reduced motor function. For many patients, a single leech therapy session is often enough to give long-lasting pain relief. During the resulting pain-free intervals, many patients can cope without using analgesic medication.

### Epicondylitis

Chronic epicondylitis is characterised by prevalent pain with impaired motor function. The condition is known for its limited response to treatment.

A randomised controlled trial compared a single session of leech therapy to topical diclofenac use in 40 patients with painful epicondylitis of at least 1 month's duration [32]. The diclofenac cream was applied twice daily throughout the 30 day study. Patients' pain was measured at intervals, at rest, on motion and during gripping, using a VAS. Follow-up measures were also taken at Day 45. Various movement disability and quality of life parameters were also documented using relevant questionnaires. The results showed that the leech therapy patients reported significantly greater pain relief at Day 7 than the diclofenac group. Evidence of superior, although non-significant, efficacy persisted in the leech therapy group at Day 45. Patients' functional disability scores (disabilities of the arm, shoulder and hand (DASH) [33]) also showed greater improvement in the leech therapy group, being most prominent ( $p=0.0075$ ) after 45 days. Leech therapy patients also reported that their quality of life was improved post-treatment, although non-significantly. The authors mentioned that no serious adverse events were observed in this study. The adverse events of leech therapy included mild to moderate itching and reddening of the skin, which emerged 1-7 days post-leech application in 10 of 20 patients. The itching, which lasted for a mean of 5 days, did not require further treatment. Two leech therapy patients experienced a moderate decrease in systolic blood pressure, with mild sensations of dizziness for several minutes after leech application. Again, this did not require further therapeutic intervention. In the diclofenac control group, only 1 of 20 patients noted mild local skin reactions.

Case reports noting leech therapy's value in various forms of painful tendinitis and tenosynovitis are cited by Müller [31]. Michalsen and Roth [10] also recommended leech therapy, in these conditions amongst others, in their more recent handbook.

#### *Vertebrogenic pain syndromes/lower back pain (Lumbago)*

Leech therapy can be a useful adjunct to physiotherapy and to pain management in various back pain syndromes, in particular in cases of increased muscular tension and in inflammatory conditions. Myalgia and myogelosis are common major symptoms of back pain. These symptoms can be improved by the analgesic, anti-inflammatory and blood circulation enhancing effects of leech saliva's ingredients.

An early article by Oberheid [34] noted remarkable analgesic effects from leech therapy on various forms of back pain, based on clinical experience. Müller [31] supported this view, citing several authors who confirmed the pain-relieving effects of leech therapy in back conditions. A more recent review article by Michalsen [35] stated that back pain syndromes are often seen to improve immediately, after leech therapy; aiding the baseline conditions for further physiotherapy measures considerably. The following adverse events were cited,

post-leech application, local itching, delayed healing of leech bite wounds and pseudo-allergic erythema.

#### *Hematoma/swelling/oedema/contusion/distortion*

Leech therapy's analgesic effects on pain due to haematoma and swelling result from the removal of excess blood and the thrombolytic effect of the salivary ingredients [36, 37].

Pain relief and reduced swelling are cited in numerous case reports. Leech therapy has been used successfully in various forms of head and neck surgery. For example, Menage and Wright [38] report its detumescent and pain-relieving action in severe peri-orbital haematoma. Other reports describe successful leech treatment in cases of sublingual haematoma [39, 40] and massive, at times life-threatening, macroglossia (tongue swelling) secondary to blunt trauma [41], tooth implant surgery [42] and intra-oral surgery [43].

In a more recent review article, Porshinsky et al. [44] cite published reports of leech therapy for massive post-traumatic lingual swellings. They conclude that clinical results were satisfactory in these cases, with resolution of the original swelling and only minor post-leeching glosal puncture marks as adverse reactions. They also note that the continued drainage of dark, non-clotted, blood from the leech attachment sites seen, suggests that haematoma resolution may continue for some time post-leech detachment.

Leech therapy has also proven successful in reducing haematoma and swelling pain at other body sites [45], including cases of massive scrotal haematoma caused by blunt trauma [46], following vessel wall rupture after percutaneous transluminal angioplasty [47], in transfemoral puncture for cardiac cauterisation [48, 49] and in radical radiotherapy [50].

Leech therapy has also been used successfully for reducing swelling and pain after reconstructive surgery [51, 52]. A long-standing review article by Deuser [53] described the value of leeches in treating various sports medicine injuries involving swelling. Such views have been echoed in more recent anecdotal accounts in soccer and ice hockey players [54]. These accounts include an article in the English 'The Sun' newspaper, citing leech application's value in treating a professional soccer player with a chronically swollen knee [55].

#### *Varicose veins/leg ulcer/phlebitis/thrombophlebitis*

Pain, pressure sensations and feelings of swelling and heaviness are common in cases of restricted blood flow, vessel or tissue inflammation, and are due to venous stasis. The analgesic effects of leech therapy in treating varicose veins, has long been recognised in the literature of internal medicine [31, 34, 56]. A clinical study by Bapat et al. [57] supports such views, finding leech therapy (1-4 leeches for 2-20 sessions) an effective adjunct in manag-

ing complicated, painful varicose veins and leg ulcers in 19 patients. None of the potential complications of leech therapy in these conditions, such as wound infection or excessive bleeding, were seen in this study.

In similar fashion, Zarnigar [58] found a marked reduction in pain, and complete healing of severe varicose vein ulcers, in three out of four patients following leech therapy for a period of 60 days. Leeching was described as safe and well-tolerated in these patients.

Further articles describing the successful use of leech therapy for varicose veins confirm these findings [34, 59–61].

Many individual case presentations also describe the pain-reducing effects of leech therapy in phlebitis and thrombophlebitis [34, 62–69].

### Cancer pain

Finally, Kalender et al. [70] reported the use of leech therapy in a patient with renal cell carcinoma and leiomyosarcoma whose severe lumbar pain remained unresolved by radiotherapy, systemic or epidural analgesic infusions. This patient became pain-free following leech therapy. The authors noted that this first report of leech therapy's use in cancer pain suggests possible analgesic benefits in this indication, demanding for further investigation.

### Discussion

Leech therapy has been used in a wide variety of clinical pain conditions to date. Whilst pharmacological studies have shown that leech saliva has anti-inflammatory, anticoagulant, thrombolytic, blood and lymph circulation enhancing effects [6], they have yet to identify the biochemical or pharmacological substances or mechanisms responsible for the analgesic action of leech therapy. Additional biochemical analyses, linked to clinical experience, are needed to further illuminate this area.

Clinical results consistently indicate a strong and long-lasting pain-reducing effect from leech therapy, particularly in patients with osteoarthritis of the knee, but the methodological pitfalls of investigating such therapy are challenging. Leech therapy's nature does not allow for the use of credible 'blinding' techniques. Attempts in this direction (use of an optical shield, leech bite simulation by needle prick and use of wet gauze to simulate a leech body), tried by Andereya et al. [17], proved unsuccessful. A placebo effect must therefore be taken into account when interpreting any leech therapy study results.

The literature search located no controlled, long-term studies comparing conventional and leech therapy in clinical pain syndromes. The duration of patients' pain reduction from leech therapy therefore remains unclear, although clinical experience in patients with osteoarthritic knee pain suggests that benefits may appear rapidly and persist for several months.

The available data also contain insufficient information on dose efficacy ratios in leech therapy, with research generally reporting only the number of leeches applied, commonly 2–8 per session. Further studies are needed to investigate potential relationships between the number of leeches applied and the onset of their action, or the effect size over time.

To compare the benefit/risk ratio of conventional and leech therapy for clinical pain syndromes, the relative adverse effects of these two approaches must be weighed and leech therapy's safety record taken into account. Definite and common adverse reactions from leech therapy are related to leeches' mode of action: slight bleeding for some hours and mild skin reactions (e.g., reddening and itching) at the bite site. Rare cases of local allergic reactions to leech therapy, which have been reported, also require attention. Whilst the long-term use of conventional analgesics (e.g., non-steroidal anti-inflammatory drugs [NSAIDs]) has well-known systemic effects; leech therapy's analgesic effects are localised. For patients who experience persistent reactions to conventional analgesics, leech therapy may prove a valid alternative.

Finally, a German study compared the cost of conventional and leech therapies in reconstructive surgery, including the treatment of painful haematomas [52]. They found that leech therapy was much less expensive than its conventional comparators.

### Conclusions

Leech therapy works by bloodletting and mainly by injecting active ingredients in leech saliva into patients' tissues. Although pain reduction of leech therapy has been noted clinically for a long time, a specific analgesic substance in leech saliva is yet to be found. Further work is needed to determine the precise mechanisms behind leech therapy's analgesic effects.

### Conflict of interest

No funding was provided for this paper.

Michael Aurich and Detlev Koeppen are scientific staff members of the leech breeding facility Biebertaler Blutegelzucht GmbH in Biebertal/Germany.

Thomas Rampp is Assistant Medical Director of the Department of Internal and Integrative Medicine at Kliniken Essen-Mitte, Faculty of Medicine University Duisburg-Essen/Germany.

### References

1. Hyson JM. Leech therapy: a history. *J Hist Dent.* 2005;53(1):25–7.
2. Munshi Y, Ara I, Rafique H, Ahmad Z. Leeching in the history. *Pak J Biol Sci.* 2008;11:1650–3.
3. Whitaker IS, Rao J, Izadi D, Butler PE. Historical article: *Hirudo medicinalis*: ancient origins of, and trends in the use of medicinal leeches throughout history. *Br J Oral Maxillofac Surg.* 2004;42:133–7.

4. Petrauskiene L, Utevska O, Utevska S. Reproduction biology and ecological strategies of three species of medicinal leeches (genus *Hirudo*). *J Nat Hist*. 2011;45(11-12):737-47.
5. BfArM. 2007. Mitteilung zu Blutegeln in der Humanmedizin: Leitlinie zur Sicherung von Qualität und Unbedenklichkeit. <http://www.bfarm.de/DE/Pharmakovigilanz/mitteil/miitl-blutegel.html>.
6. Hildebrandt JP, Lemke S. Small bite, large impact-saliva and salivary molecules in the medicinal leech, *Hirudo medicinalis*. *Naturwissenschaften*. 2011;98:995-1008.
7. Baskova IP, Zavalova LL, Basanova AV, Moshkovskii SA, Zgoda VG. Protein profiling of the medicinal leech salivary gland secretion by proteomic analytical methods. *Biochemistry*. 2004;69(7):770-5.
8. Yanes O, Villanueva J, Querol E, Aviles FX. Functional screening of serine protease inhibitors in the medicinal leech *Hirudo medicinalis* monitored by intensity fading MALDI-TOF MS. *Mol Cell Proteomics*. 2005;4:1602-13.
9. Baskova IP, Zavalova LL. Proteinase inhibitors from the medicinal leech *Hirudo medicinalis*. *Biochemistry*. 2001;66(12):869-83.
10. Michalsen A, Roth M. *Blutegeltherapie*. Stuttgart: Haug; 2012.
11. Mann KH. *Leeches (Hirudinea). Their structure, physiology, ecology, and embryology*. Pergamon Press. Oxford; 1962.
12. Rigbi M, Levy H, Eldor A, Iraqi F, Teitelbaum M, Orevi M, Horovitz A, Galun R. The saliva of the medicinal leech *Hirudo medicinalis*-II. Inhibition of platelet aggregation and of leukocyte activity and examination of reputed anaesthetic effects. *Comp Biochem Physiol C*. 1987;88:95-8.
13. Michalsen A, Deuse U, Esch T, Dobos G, Moebus S. Effect of leeches therapy (*Hirudo medicinalis*) in painful osteoarthritis of the knee: a pilot study. *Ann Rheum Dis*. 2001;60:986.
14. Michalsen A, Moebus S, Spahn G, Esch TR, Langhorst J, Dobos GJ. Leech therapy for symptomatic treatment of knee osteoarthritis: results and implications of a pilot study. *Altern Ther Health Med*. 2002;8:84-8.
15. Michalsen A, Klotz S, Lüdtke R, Möbus S, Spahn G, Dobos GJ. Effectiveness of leech therapy in osteoarthritis of the knee: a randomized controlled trial. *Ann Intern Med*. 2003;139(9):724-30.
16. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol*. 1988;15:1833-40.
17. Andereya S, Stanzel S, Maus U, Müller-Rath R, Mumme T, Siebert CH, Stock F, Schneider U. Assessment of leech therapy for knee osteoarthritis. A randomized study. *Acta Orthop*. 2008;79(2):235-43.
18. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynson BD. Knee injury and osteoarthritis outcome score (KOOS)—development of a self-administered outcome measure. *J Ortho Sports Physical Ther*. 1998;28:88-96.
19. Stange R, Moser C, Hopfenmüller W, Mansmann U, Bühring M, Ühleke B. Randomised controlled trial with medicinal leeches for osteoarthritis of the knee. *Complement Ther Med*. 2012;20(1):1-7.
20. Lequesne M, Mery C, Samson M, Gerard P. Indexes of severity for osteoarthritis of the hip and knee: validation—value in comparison with other assessments tests. *Scand J Rheumatol Suppl*. 1987;65:85-9.
21. Lauche R, Cramer H, Langhorst J, Dobos GJ. A systematic review and meta-analysis of medical leech therapy for osteoarthritis of the knee. *Clin J Pain*. 2013 (in press).
22. Abbas Zaidi SMA, Jamil SS, Sultana A, Zaman F, Fuzail M. Safety and efficacy of leeching therapy for symptomatic knee osteoarthritis using Indian medicinal leech. *Indian J Tradit Knowl*. 2009;8(3):437-42.
23. Rai PK, Singh AK, Singh OP, Rai NP, Dwivedi AK. Efficacy of leech therapy in the management of osteoarthritis (Sandhivata). *Ayu*. 2011;32(2):213-7.
24. Kumar SA, Prakash SO. Analgesic and anti-inflammatory activity of leech therapy in the management of arthritis. *Int Res J Pharm*. 2011;2(12):172-4.
25. Kumar SA, Prakash SO. Analgesic and anti-inflammatory effect of leech therapy (jalaukavcharan) in patients with osteoarthritis (Sandhigata Vata). *Int Res J Pharm*. 2012;3(2):104-7.
26. Shiffa M, Siddiqui MA, Sultana A, Zaman F, Fahamiya N, Akhtare MU. Comparative clinical evaluation of leech therapy in the treatment of knee osteoarthritis. *Eur J Integr Med*. 2013;5(3):261-269.
27. Teut M, Warning A. *Blutegel, Phytotherapie und Physiotherapie bei Gonarthrose—eine geriatrische Fallstudie*. *Forsch Komplementärmed*. 2008;15:269-72.
28. Flecken P, Michalsen A. Indications for leech therapy. In: Michalsen A, Roth M, Dobos G. *Medicinal leech therapy*. 2007. pp 66-83.
29. Michalsen A, Lüdtke R, Cesur O, Afra D, Musial F, Bäcker M, Fink M, Dobos GJ. Effectiveness of leech therapy in women with symptomatic arthrosis of the first carpometacarpal joint: a randomized controlled trial. *Pain*. 2008;137:452-9.
30. Aurich M, Koeppen D. Eine Anwenderumfrage zur Blutegeltherapie-Auswertung von 171 Falldokumentationen. *Z Komplementärmedizin ZKM*. 2009;5:12-8.
31. Müller TW. *Handbuch der Blutegeltherapie*. Stuttgart: Haug; 2000.
32. Bäcker M, Lüdtke R, Afra D, Cesur O, Langhorst J, Fink M, Bachmann J, Dobos GJ, Michalsen A. Effectiveness of leech therapy in chronic lateral epicondylitis: a randomized controlled trial. *Clin J Pain*. 2011;27(5):442-7.
33. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). The Upper Extremity Collaborative Group (UECG). *Am J Ind Med*. 1996;29:602-8.
34. Oberheid L. Über Blutegelbehandlung. *Münchener Med Wochenschr*. 1940;35:942-4.
35. Michalsen A. Blutegeltherapie bei chronischen Rückenschmerzen. *Z Komplementärmedizin ZKM*. 2009;2:1-3.
36. Baskova I, Nikonov GI. Destabilase, the Novel Epsilon-(Gamma-Glu)-Lys Isopeptide with thrombolytic activity. *Blood Coagul Fibrinolysis*. 1991;2:167-72.
37. Zavalova LL, Baskova IP, Basanova AV, et al. Proposed mechanisms of thrombolytic action of the medicinal leech saliva. *J Thromb Haemost*. 2003;1(suppl. 1):1838 (abstract).
38. Menage MJ, Wright G. Use of leeches in case of severe periorbital haematoma. *Br J Ophthalmol*. 1991;75(12):755-6.
39. Grossman MD, Karlovitz A. Lingual trauma: the use of medicinal leeches in the treatment of massive lingual haematoma. *J Trauma*. 1998;44:1083-5.
40. Lee NJ, Peckitt NS. Treatment of a sublingual hematoma with medicinal leeches: report of a case. *J Oral Maxillofac Surg*. 1996;54:101-3.
41. Byrne PJ, Bernstein PE. The use of medicinal leeches to treat macroglossia secondary to blunt trauma. *Otolaryngol Head Neck Surg*. 2001;12:649-50.

42. Ramzan M, Droog W, Sleswijk V, van Roessel EW, Meynaar IA. Leech got your tongue? Haematoma of the tongue treated with medicinal leeches: a case report. *Neth J Crit Care*. 2010;14(4):268–70.
43. Smeets IM, Engelberts I. The use of leeches in a case of post-operative life-threatening macroglossia. *J Laryngol Otol*. 1995;109:442–4.
44. Porshinski BS, Saha S, Grossman MD, Beery P, Stawicki S. Clinical uses of the medicinal leech: a practical review. *J Postgrad Med*. 2011;57:65–71.
45. Godfrey K. Use of leeches and leech saliva in clinical practice. *Nurs Times*. 1997;93:62–3.
46. Isgar B, Turner AG. Large scrotal haematoma treated with medicinal leeches. *Br J Urol*. 1989;64(5):549–50.
47. Goessel C, Steffen-Wilcke K, Miller K. Leech therapy for massive scrotal haematoma following percutaneous transluminal angioplasty. *J Urol*. 1997;158(2):545.
48. Borden TA, Rosen RT, Schwarz GR. Massive scrotal hematoma developing after transfemoral cardiac catheterization. *Am Surg*. 1974;40:193.
49. Heckmann JG, Dütsch M, Neundörfer B, Hartung U. Leech therapy in the treatment of median nerve compression due to forearm haematoma. *J Neurol Neurosurg Psychiatry*. 2005;76(10):1465.
50. Philip J, Armitage DW, Phillips KR, Parr NJ. Leech therapy for penoscrotal oedema in patients with hormone-refractory prostate carcinoma. *BJU Int*. 2003;91:579–80.
51. Makin CA, Edwards L. Application of leeches to reduce swelling after surgery. *Br J Urol*. 1987;59:189.
52. Riede F, Koenen W, Goerdts S, Ehmke H, Faulhaber J. Der Einsatz medizinischer Blutegel zur Therapie der venösen Stase und von Hämatomen bei Lappenplastiken. *J Dtsch Dermatol Ges JDDG*. 2010;8:1–9.
53. Deuser E. Über Behandlungsmethoden von Distorsionen, Kontusionen und Hämatomen im Sportgeschehen. *Sportarzt Sportmed*. 1971;22:2–113.
54. Media Park Clinic, Cologne/Germany 2011.
55. The Sun, Sports article, 2 September 2010.
56. Bottenberg H. Die Blutegelbehandlung. Stuttgart: Hippokrates; 1935.
57. Bapat RD, Acharya BS, Jukevar S, Dahanukar SA. Leech therapy for complicated varicose veins. *Indian J Med Res*. 1998;107:281–4.
58. Zarnigar AA. Clinical efficacy of leech therapy in varicose ulcer—a case series. *Unani Res*. 2011;1:31–8.
59. Erbacher U. Venenerkrankungen, Blutegeltherapie. *Der Heilpraktiker*. Verlag Volksheilkunde. 2002:6–9.
60. Keller A. Krampfadern, Venenentzündungen und Hämorrhoiden. Ursachen, Verhütung und Naturheilung der Krampfadern, Venenentzündung und Hämorrhoiden. Schwab, Gelnhausen. 1963.
61. Shchetokow GM. Die Anwendung von Blutegeln bei varikös erweiterten Venen. *Voenno-Meditsinski Zhurnal*. 1980;3:68.
62. Bulling B. Die Behandlung der Thrombophlebitis mit Blutegeln. *Vasomed*. 2010;22(1):6.
63. Hauptstein P. Die Blutegelbehandlung der Thrombophlebitis nach Operation und im Wochenbett. *Med Welt*. 1934;8:1723–25.
64. Kutakow OI. Hirudinationsbehandlung bei Thrombophlebitis. *Klinicheskaya Meditsina*. 1965;43:120–3.
65. Mahorner HR, Ochsner A. The use of leeches in the treatment of phlebitis and the prevention of pulmonary embolism. *Ann Surg*. 1933;98(3):408–21.
66. Meyer E. Die Blutegelbehandlung von Thrombosen und Thrombophlebitiden. *Therapie der Gegenwart*. 1935;76:18–20.
67. Oden HG. Zur Blutegeltherapie bei Thrombophlebitis. *Med Welt*. 1933;7:273–4.
68. Wesener G. Behandlung der oberflächlichen Thrombophlebitis. *Ärztliche Praxis*. 1965;17:1660–1.
69. Wesener G. Zur Diagnose und Therapie der oberflächlichen Thrombophlebitis (Varicophlebitis) in der Sprechstunde. *Z Haut- Geschlechtskrankh*. 1967;22:61–8.
70. Kalender ME, Comez G, Sevinc A, Dirier A, Camci C. Leech therapy for symptomatic relief of cancer pain. *Pain Med*. 2010;11(3):443–5.