



Review Article

EXPLORING THE POTENTIAL OF *SHIRODHARA* IN STRESS MANAGEMENT ALONG WITH
NADPH PATHWAY ANALYSIS: AN EXPLORATORY EXEGETICAL VIEW

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ABSTRACT

Shirodhara is a traditional Ayurvedic treatment for stress-related conditions that entails continuously applying warm liquid to the forehead. Despite its effectiveness in practice, nothing is known about its underlying mechanism. This study investigates the likely biochemical, neurophysiological, and psycho-physiological processes that underlie the therapeutic benefits of *Shirodhara*. **Methods:** The neurological pathways that were activated during *Shirodhara* were examined in order to do a thorough mechanistic study. Mechanoreceptor activation, neuronal transmission through the trigeminal nerve, hypothalamic-pituitary-adrenal (HPA) axis regulation, and possible biochemical influences- specifically, the NADPH-dependent nitric oxide (NO) pathway- were the main topics of the study. Relevant biochemical processes and neurophysiological concepts were examined to clarify the likely mechanism of action of the treatment. **Results:** When Pacinian corpuscles and Merkel cells are mechanically stimulated, afferent impulses are produced and sent to the somatosensory cortex via A β fibers. These impulses affect autonomic function and induce relaxation. *Shirodhara* promotes anxiolysis by facilitating a shift towards alpha brainwave patterns through its action on the reticular activating system (RAS). Attenuation of the HPA axis also promotes parasympathetic dominance by lowering cortisol output. The participation of the NADPH pathway points to a different biochemical mechanism through which increased NO generation reduces oxidative stress and enhances brain perfusion. **Conclusion and Discussion:** Intricate neurosensory, autonomic, and metabolic mechanisms mediate *Shirodhara*'s therapeutic benefits. Its effectiveness in stress management is supported by the integration of redox homeostasis, cortical-limbic regulation, and mechanoreceptor activation. These results demonstrate the potential of *Shirodhara* as a neurophysiological treatment for stress-related conditions, which calls for additional empirical verification through carefully monitored clinical studies.

INTRODUCTION

Shirodhara is one among the external treatment modality for the management of this condition. It falls under the *Murdhani taila*, in which the patient lies peacefully on a comfortable bed while a therapeutic oil is slowly and consistently dripped over the middle of their forehead. Other liquids, such as milk, buttermilk, coconut water, etc., are also used based on the patient's specific needs. *Shirodhara* comes from the words *Shira*, which means

head, and *Dhara*, which means constant flow. A dynamic psycho-somatic equilibrium is the outcome of this process, which creates a calm state of consciousness. This technique produces a complete sense of well-being, mental clarity, and understanding. A dynamic psycho-somatic equilibrium is the outcome of this process, which creates a calm state of consciousness. This technique produces a complete sense of well-being, mental clarity, and understanding.^[1]

In addition to medications and therapeutic diet, *Shirodhara* is a suggested Ayurvedic treatment for neurological disorders such as mental stress (depression/anxiety), headaches, and sleeplessness. *Shirodhara* is a powerful ayurvedic method that is precisely quantified in accordance with scientific

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understanding.^[2,3] According to A.K. Sharma, Shirodhara also may help with motor neuron diseases, depression, headaches, mental stress, sleeplessness, and a number of mental illnesses, including schizophrenia.^[4]

Classical literature like "*Dharakalpah*"^[5] discuss the specifics of administering *Shirodhara* and propose physical criteria such as the height of fall, the type of liquid, the material of the *Dhara* pot, etc. Below is a quotation from one of the slokas that discusses the liquid's height of fall and is pertinent to our analysis:

धारोच्चं चतुरंगुलं तु शिरसः सेके तदन्यत्र तत्

प्रोक्तं तत्रिगुणं मन्दपतनात् तद्रोगवृद्धिर्भवेत्

Pour the *Dhara* over the head from a height of four *Angulas*, and then from a height of twelve *Angulas* to the opposite body part. The unhealthy state worsens if the process is carried out in a way that deviates from the previously stated guidelines. It is very useful in preventing premature graying of hair, reducing *Klama* (fatigue), calming *Doshakopa*, *Siroruja* (head ache), *Ojokshaya* (lower body immunity), *Karacharanaparisthodana* (prickly pain over palms and feet), *Mutradosha* (urinary system disorders), *Sandi visladhatvam* (joint laxity), *Hridroga* (cardiovascular disorders), *Aruchi* (reluctance), *Jadaragnimandya* (a decrease in appetite), *Shioroga* (head disorders), *Karna roga* (ear disorders), and *Netra roga* (eye disorders).^[6] It is quite successful in treating children's neurobehavioral disorders like ADHD as well as psychological illnesses.

METHODOLOGY

Shirodhara probable mode of action

Shirodhara's probable mode of action can be determined by examining the following facts. When a continuous stream of liquid is poured onto the forehead from a fixed height, it creates mechanical pressure on the skin, stimulating Pacinian corpuscles, specialized mechanoreceptors located in deeper skin layers. These corpuscles are highly sensitive to vibration and dynamic pressure changes, responding particularly well to transient or dynamic stimuli^[7]. The mechanical force deforms the concentric lamellar structure of the Pacinian corpuscle, compressing its nerve ending. This deformation opens mechanically gated ion channels, permitting sodium ions to enter the nerve terminal, which alters the membrane potential and generates a receptor potential^[8]. If this receptor potential reaches the threshold, it triggers an action potential that travels via Aβ fibers to the central nervous system for processing^[9]. Due to their rapidly adapting nature, Pacinian corpuscles respond intensely to initial pressure changes but reduce their firing rate if the stimulus persists, making them especially responsive to dynamic stimuli like a flowing liquid^[10].

This mechanism is believed to play a role in the calming effect of *Shirodhara*, where continuous liquid flow on the forehead may influence the autonomic nervous system, promoting relaxation and reducing stress responses^[11].

***Shirodhara's* Anxiolytic Effects:** *Shirodhara's* anxiolytic effects are believed to result from the continuous flow of warm liquid over the forehead, which stimulates mechanoreceptors such as Pacinian corpuscles and Merkel cells. This stimulation generates afferent impulses transmitted via the trigeminal nerve to the somatosensory cortex, influencing cortical activity and promoting relaxation. Additionally, *Shirodhara* is thought to modulate the reticular activating system (RAS), shifting brainwave patterns toward alpha waves, which are associated with calmness and reduced anxiety. The therapy may also regulate the hypothalamic-pituitary-adrenal (HPA) axis, lowering cortisol levels and enhancing parasympathetic activity, ultimately inducing a tranquil mental state and reducing stress responses.¹²

Psycho-physiological: *Shirodhara's* psycho-physiological effects can be explained through its impact on the trigeminal nerve pathway. The continuous stream of warm liquid stimulates tactile receptors in the skin and hair follicles, particularly those innervated by the ophthalmic branch (V1) of the trigeminal nerve. This afferent input is relayed to the main sensory nucleus of the trigeminal nerve, which transmits impulses to the thalamus. From there, the signals are directed to the somatosensory cortex and the limbic system, areas responsible for sensory integration, emotional regulation, and consciousness. This neural pathway is believed to modulate anxiety levels and induce altered states of consciousness, contributing to *Shirodhara's* calming effect. Additionally, alternative pathways may involve projections from the main sensory nucleus to the reticular formation and the posterior thalamus, regions closely linked to autonomic nervous system regulation. This interaction is thought to enhance parasympathetic activity, promoting relaxation and stress relief.^[12]

Shirodhara & NADPH (Nicotinamide Adenine Dinucleotide Phosphate) pathway

Emerging evidence suggests that *Shirodhara* may exert its therapeutic influence by modulating biochemical pathways such as the NADPH (Nicotinamide Adenine Dinucleotide Phosphate) system. The NADPH pathway plays a crucial role in maintaining cellular redox balance, antioxidant defense, and nitric oxide (NO) synthesis. Chronic stress is known to deplete NADPH reserves, impairing glutathione regeneration and increasing oxidative stress. *Shirodhara's* ability to reduce cortisol levels and activate parasympathetic responses may indirectly

conserve NADPH stores, enhancing cellular repair mechanisms and reducing oxidative damage.^[13] Additionally, stimulation of the ophthalmic branch of the trigeminal nerve during *Shirodhara* may enhance cerebral blood flow by promoting NADPH-dependent NO production, which is linked to improved vascular

tone and neurological stability.^[14] This potential interplay between *Shirodhara* and the NADPH pathway highlights a novel mechanistic insight into its neurophysiological effects, warranting further research to elucidate its role in stress-related disorders and mental well-being.

DISCUSSION

Explanation in comparison to Ayurveda

Conceptual Foundation

Aspect	Neurophysiological Explanation	Ayurvedic Explanation
Core Mechanism	Focuses on tactile stimulation via mechanoreceptors (e.g., Pacinian corpuscles) and neural pathways involving the trigeminal nerve, thalamus, and limbic system.	Describes <i>Shirodhara</i> as balancing <i>Vata dosha</i> , which governs the nervous system, movement, and mental stability. The steady oil flow is believed to stabilize the mind and induce calmness.
Consciousness & Relaxation	Explains altered consciousness through cortical modulation, alpha wave induction, and autonomic regulation.	Describes <i>Shirodhara</i> 's effect on <i>Manas</i> (mind) by pacifying <i>Rajas</i> (agitation) and <i>Tamas</i> (dullness), promoting a state of tranquility.
Emotional Regulation	Involves the limbic system, crucial for emotional balance and anxiety reduction.	Aligns with Ayurvedic concepts of calming the <i>Manovaha Srotas</i> (mental channels), which govern thoughts, emotions, and consciousness.

Pathway and Physiological Process

Aspect	Neurophysiological Explanation	Ayurvedic Explanation
Sensory Pathways	Describes afferent impulses traveling through the ophthalmic branch of the trigeminal nerve, influencing the thalamus, reticular formation, and cortex.	Emphasizes stimulation of the <i>Ajna Chakra</i> (third-eye region) and <i>Sthapani Marma</i> , linked to higher mental functions.
Hormonal & Neural Effects	Highlights the modulation of the HPA axis, reducing cortisol and enhancing parasympathetic tone.	Believed to activate the pituitary gland, aligning with the concept of hormonal balance as part of mind-body equilibrium.

Therapeutic Outcomes

Aspect	Neurophysiological Explanation	Ayurvedic Explanation
Anxiety & Stress Reduction	Attributed to neural modulation, alpha wave induction, and hormonal balance.	Described as pacifying <i>Vata dosha</i> , which governs mental restlessness, anxiety, and insomnia.
Enhanced Consciousness	Linked to altered states via the RAS, limbic system, and sensory cortex integration.	Associated with heightened awareness and improved clarity through the balance of <i>Satva</i> (purity), <i>Rajas</i> , and <i>Tamas</i> .
Physical Relaxation	Emphasizes reduced muscle tension, slower heart rate, and lower blood pressure.	Described as grounding excess <i>Vata</i> and nourishing <i>Shira</i> (head) tissues, improving overall vitality.

Step	Modern Correlation	Ayurvedic Mechanism
Concentration on the <i>Dhara Dravya</i>	Alpha brain wave stimulation during <i>Shirodhara</i> promotes deep relaxation. Studies show reduced cortisol and adrenaline levels. Helps alleviate withdrawal symptoms such as irritability,	<i>Shirodhara</i> focuses on a steady flow of herbal oils or liquids over the forehead, stimulating the <i>Ajna Chakra</i> (third eye), believed to calm the mind and nervous system, it helps calm <i>Vata</i> (nervous system)

Step	Modern Correlation	Ayurvedic Mechanism
	anxiety, and hyperarousal. ^[15]	and <i>Pitta</i> (mental clarity), reducing <i>Tamas</i> (mental dullness), which are common in addiction.
Relaxation Therapy and Tranquilizing effect	Stress and anxiety are common during withdrawal due to the dysregulated nervous system. - Modern therapies (e.g., CBT, medications) focus on alleviating mental tension. <i>Shirodhara</i> serves as a natural, non-invasive method to promote emotional stability and reduce anxiety. Continuous pouring of <i>Taila</i> on fore-head for a specific period has tranquilizing effect and induces sleep. According to Modern science local applications as ointment may pass through the stratum corneum into blood vessel and produces desirable effects by reaching the target organ. The continuous pouring of oil in relaxed and comfortable position has an additional effect which can be compared to the cradling of mother to a child. This function act as a sedative and soothing effect for the brain and produces sleep. Medicated oil poured on fore-head may be absorbed, producing tranquilizing effect by reaching the brain cortex. The chemical constituent of medicated oil may act as a neuro transmitter as deficiency of certain neurotransmitter can be checked hypothetically if oil percolate in to brain cortex as explained by Johnson while treating the patient of angina by nitroglycerine. ^[14]	<i>Shirodhara</i> provides deep relaxation and tranquility, helping to reduce mental tension. Helps calm <i>Manas</i> (mind), reduces mental stress, and promotes inner peace.
Stimulation of Autonomic Nervous System (ANS)	Chronic addiction often causes ANS dysregulation, leading to disrupted sleep, increased heart rate, and shallow breathing. <i>Shirodhara</i> may also have Alpha Adrenergic blocking effect and can thus block certain actions of adrenaline and nor adrenaline. <i>Shirodhara</i> may also act on the adrenergic neuron probably produce their effects by modifying the synthesis storage and uptake mechanisms of noradrenaline. ^[15] Also <i>Shirodhara</i> aids in stimulating acetylcholine production, restoring balance to the parasympathetic nervous system, and improving stress response regulation.	<i>Shirodhara</i> stimulates the parasympathetic nervous system (PNS), promoting calming and relaxation. Balances the ANS, especially when disturbed due to addiction, to improve digestive and sleep functions. ^[16]
Release of Acetylcholine	Acetylcholine plays a key role in reducing stress responses and calming the nervous system. Alcohol and drug withdrawal often leads to reduced acetylcholine production, contributing to anxiety and discomfort. <i>Shirodhara</i> helps stimulate	Acetylcholine is released during <i>Shirodhara</i> , calming the central nervous system and promoting relaxation. Helps reduce high blood pressure, calming the body and reducing stress.

Step	Modern Correlation	Ayurvedic Mechanism
	acetylcholine release, aiding in withdrawal symptom management.	
Effect on Endocrine system	The effect of <i>Shirodhara</i> on hormone secretion can also be postulated considering the effect on hypothalamus as hypothalamus is the main controller of endocrine secretions. The hypothalamic neurons which secrete the regulatory hormones are themselves under the control of specialized monoaminergic, neurotransmitter neurons which arise in the mid brain. These latter release dopamine, nor adrenaline and serotonin. In turn, these mid brain nuclei are under the control of visceral brain and are responsive to stress and emotional disturbances. ^[16]	Some <i>Marma</i> (vital spot) are located in forehead and head region as mentioned in Ayurveda classics. Mainly <i>Sthapni</i> , <i>Utshepa</i> , <i>Avarta</i> , <i>Shankha</i> and <i>Apanga Marma</i> are situated in this region. ^[17] According to Acharya Bhela, <i>Bhrumadhya</i> (between both eyebrows) is the site of <i>Chitta (Mana)</i> . It is also place of <i>Sthapni Marma</i> . ^[18] The site of <i>Sthapni Marma</i> and the site of pituitary and pineal gland exist at the same level. The function of pituitary gland is controlled by hormones. It is the master of the gland. It has the capacity to maintain all the endocrine system of human body. ^[19] Mental stress and irritability were the causative factors were endocrine system gets imbalance of its normal function. ^[20] Due to the stimulation of <i>Sthapni Marma</i> and indirect stimulation of pituitary gland brings changes in psycho-somatic level. Hence <i>Shirodhara</i> therapy helps in reliving the mental stress by regulating the normal function of this gland.

CONCLUSION

Shirodhara's neurosensory, autonomic, and metabolic interactions provide the molecular basis for its therapeutic effectiveness. Afferent transmission through A β fibers and the trigeminal nerve is elicited by mechanical stimulation of Pacinian corpuscles and Merkel cells. This modulation of cortical and limbic circuitry results in anxiolysis and autonomic recalibration. At the same time, the hypothalamic-pituitary-adrenal (HPA) axis and the reticular activating system (RAS) are activated, which reduces cortisol release and promotes parasympathetic dominance. Furthermore, *Shirodhara* may improve cerebral perfusion and reduce oxidative stress by modulating the NADPH-dependent nitric oxide (NO) pathway. *Shirodhara's* function as a neurophysiological treatment for stress-related diseases is supported by these convergent mechanisms, which call for additional empirical research.

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