

Scientific exploration on physiological basis of Svedana Karma (Sudation): A clinical application of heat stress.

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ABSTRACT

Now researchers have focused attention on exploring the mechanism of acute responses of heat stress given in heat therapy that ultimately promotes the long term health benefits. Heat therapy is not a new idea rather it was practiced since thousands years back in the form of hot bath, sauna bath, steam room. Similarly in Ayurveda there is very comprehensive description of heat therapy in the form of Svedan karma (Sudation therapy). Svedan is a process to induce sweating artificially in a patient who had already undergone Snehan. Svedan is applied for purification of body, as well as in management of various disorders originated due to vitiation of Vata, Kapha Dosha, Meda Dhatu and musculoskeletal disorders. It produces various beneficial effects by augmenting the Agni like clears the channels, liquefies the deposited Dosha, regulates Vata Dosha, helps in removal and pacification of Dosha, augments metabolism (Agni Deepan), increases appetite, flexibility in body parts, softness and shining of skin, removes coldness, stiffness, drowsiness, improves joint motility.

However, Svedana karma is vastly used by Ayurveda Physicians in treatment of various disorders but the mechanisms of beneficial effects produced by Svedan Karma are yet not completely explored on scientific basis. In this article, we will discuss and try to establish a possible mechanism of action of Svedana karma in relation to heat stress, mitochondrial adaptation, heat shock protein (HSP) and glucocorticoids as these are secreted under stressful conditions.

Keywords: Heat therapy, Svedana(Sudation), Panchkarma, Heat shock protein

INTRODUCTION

Svedana karma (Sudation) is a procedure to induce sweating by heating the body. It is of two kinds i.e. Saagni and Niraagni. In Saagni Sveda, sweating is induced by applying external heat via various methods; it is similar to passive heat therapy. While in Niragni Sveda, sweating is induced without application of external heat rather heat generation in body is increased by adopting certain measures e.g. doing exercise, heavy clothing etc. Svedana is used as Purvakarma (pre-procedure) before Panchakarma procedures and also as main treatment modality for pacification and removal of Vriddha Dosha. Tridosha are biological entity present in each and every cell of the body, responsible for both physiological and pathological states in the body. Sweating is produced because of Ushna property (hot potency) of Pitta Dosha. Sweating is a physiological phenomenon for temperature regulation of the body and also helps in excretion of various metabolites. There is physiological variation in quantity and quality of sweat as per psychosomatic constitution (Charak Samhita Vimanasthana 8/96). Normal

sweating reflects the physiological state of the Pitta dosha, Vyana and Samana Vata and Svedavahasrotas. Excessive and less sweating has been described as a characteristic in various disorders like Kushtha, Vatarakta and excessive sweating in Meda Rogas, Jwar. (Charak Samhita Chikitsasthana 7/12; 29/16; Charak Samhita Sutrasthana 21/4). When an individual adopts unhealthy dietary regimen for long time the Dosha get vitiated. The vitiated Dosha circulate in whole body and get lodged in various channels (Khavaigunya) and produce various ailments in them.

Ayurveda has advised various measures to balance Vriddha Dosha among them are Purvakarma (Snehana and Svedan), Pradhana Panchakarma i.e. five procedures to remove Mala i.e. vitiated Dosha and toxins accumulated in the Srotas from body by targeting the different Srotas i.e. Purishavha, Mutravaha, Svedavaha Srotas. Purvakarma (pre-procedures) is done before Panchakarma and by applying Purvakarma i.e. Snehan and Svedan, the accumulated Dosha in minute Srotas gets mobilized to Kostha.

Ayurveda scholars were well acquainted with the function of sweat and Svedavahasrotas like eliminating toxins have successfully designed and introduced as the Svedan Chikitsa. Svedan is a process to induce sweating artificially in a patient who had already undergone Snehan etc. Effects produced by Svedan are it liquefies the Doshas, (eliminates the metabolic waste), clears the obstruction of channels (improves circulation, exchange across cell membrane), reduces water retention i.e.

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Received Jul 25, 2019; Accepted Aug 13, 2019; Published Aug 31 2019

doi: <http://dx.doi.org/10.5667/tang.2019.0012>

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reduces Stambha (stiffness), Vatanulomana and directs the Dosha to selective places from where they can be expelled easily. Snehan and Svedan are majorly used procedure out of ShadvidhaChikitsaUpkrama, so there is need to explore the possible mechanism of action of Svedan in relation to contemporary science because the people of present era are more inquisitive about mechanism of action and they are not much aware to Dosha principles. So in this review article mode of action of Svedan Karma is explained with help of available literature of traditional and contemporary science.

MATERIALS AND METHODS

A comprehensive study was undertaken on the descriptions of Svedan karma, Purvakarma found in different Ayurvedic Samhita. Descriptions were collected from various Ayurvedic Samhita and research papers published in scholarly journals were searched online from scientific electronic databases viz. PubMed, Google scholar, Science Direct by using the following key phrases: sweating, effects of Svedan karma, Panchakarma, stress response to heat and application of heat therapy. Results were analyzed in view of contemporary science to understand the physiological basis of Svedan Karma and its applications described in Ayurveda.

REVIEW AND DISCUSSION

Svedan Karma

Svedan Karma is one of the important procedures in Poorvakarma and Shadvidhupakram employed for the treatment of various diseases or removal of VriddhaDosha from the body. Principally, Svedan (fomentation) is designed to induce sweating by application of heat. It may be administrated as Poorvakarma or chief procedure or Paschata Karma. In Svedan Karma sweating is induced by application of external heat to the body (SaagniSveda) or heat production is increased by adopting some modality (NiraagniSveda) like Vyayam(physical activity), Gurupravarna (warm clothing)etc. As a matter of fact secretion of sweat is the physiological function of the body, but some artificial means can be employed for increased production of sweat in various diseases especially associated with stiffness, heaviness and coldness. Depending upon the etiology, severity and symptoms of the disease, it may be either RukshaSvedan (without prior oleation therapy) or SnigdhaSvedan (with prior oleation therapy) or Niragni (without external application of heat) and SaagniSvedan (application of external heat). It has a significant role in curing the various diseases but due to faulty intervention may result in various complications. So it is always

DvididhaBheda(2 types)	As per <i>Sthana</i> (site) 1. <i>Ekanga Sveda</i> 2. <i>SarvangaSveda</i> (Charak Samhita Sutrasthana 14/65-66)	As per <i>Agni</i> (heat application) 1. <i>Sagni</i> 2. <i>Niragni</i> (Charak Samhita Sutrasthana 14/64-65)	Aa per <i>Guna</i> (property) 1. <i>Ruksha Sveda</i> 2. <i>SnigdhaSveda</i> (Charak Samhita Sutrasthana 14/64-65)
TrividhaBheda (3types)	As per <i>RogiBala&Rogabala</i> (strength of disease and patient) 1. <i>Mridu</i> 2. <i>Madhya</i> 3. <i>Maha</i> (Charak Samhita Sutrasthana 14/7)		
Chaturvidha (4 types)	1. <i>Tapa</i> 2. <i>Ushma</i> 3. <i>Upanaha</i> 4. <i>Drava</i> (Sushruta Samhita Chikitsasthana 32/3)		
Saptavidha (7 types)	1. <i>Loshtha</i> 2. <i>Vashpa</i> 3. <i>Agni</i> 4. <i>Ghati</i> 5. <i>Jala</i> 6. <i>Phala</i> 7. <i>Baluka</i> (Harita Samhita Fourth Sthana 4/1)		
Ashtavidha (8 types)	1. <i>Hasta</i> 2. <i>Pradeha</i> 3. <i>Nadi</i> 4. <i>Prastar</i> 5. <i>Sankar</i> 6. <i>Upanaaha</i> 7. <i>Avagaha</i> 8. <i>Pariseka</i> (Kashyapa Samhita Sutrasthana 23/25-26)	1. <i>Mamsa</i> 2. <i>Urada&Tila</i> 3. <i>Baluka</i> 4. <i>Kumbhi</i> 5. <i>Pinda</i> 6. <i>Ishtika</i> 7. <i>Prastar</i> 8. <i>Sankar</i> (Vangsen)	1. <i>Sankar</i> 2. <i>Prastara</i> 3. <i>Pariseka</i> 4. <i>Nadi</i> 5. <i>Droni</i> 6. <i>Jala</i> 7. <i>Upakoshtha</i> 8. <i>Kuti</i> (Bhela Samhita Sutrasthana 22/1)
Dashavidha (10 types)	1. <i>Vyayama</i> (<i>Exercise</i>) 2. <i>UshnaSadan</i> (warm Rooms) 3. <i>Guru Pravaraana</i> (Heavy Clothing) 4. <i>Kshudha</i> (Hunger) 5. <i>Bahupana</i> (Excessive Drinking)	6. <i>Bhaya</i> (Fear) 7. <i>Krodha</i> (Anger) 8. <i>Upanaha</i> (Poultice) 9. <i>Avaha</i> (War) 10. <i>Atapa</i> (Sunbath) (Sushruta Samhita Chikitsasthana 32/3; AshtangaSangrahaSutrasthana 26/17)	
Trayodashavidha (13 types)	1. <i>Sankar</i> (Mixed Fomentation) 2. <i>Prastar</i> (<i>Hot bed fomentation</i>) 3. <i>Nadi Sveda</i> (<i>Steam Cattle Fomentation</i>) 4. <i>Pariseka</i> (Sprinkling) 5. <i>Avagaha</i> (Tub Bath Sudation) 6. <i>JentakaSveda</i> (Sudatorium Sudation) 7. <i>AshmaghanaSveda</i> (Stone Bed Sudation)	8. <i>KarsuSveda</i> (Trench Sudation) 9. <i>KutiSveda</i> (Cabin Sudation) 10. <i>Bhu Sveda</i> (Ground Bed Sudation) 11. <i>KumbhiSveda</i> (Pitcher Bed Sudation) 12. <i>KoopaSveda</i> (Pit Sudation) 13. <i>HolakaSveda</i> (Under bed Sudation) (Charak Samhita Sutrasthana 14/39-40)	

Table 1. Summarizing the classification of Svedan Karma described in various text of Ayurveda.

advised to take care of guidelines for indication and contraindication of Svedan Karma, along with season to avoid adverse effect and to get adequate results.

Types of Svedan Karma

Various types of Svedan have been described depending upon the method of heat application to induce sweat and the body part on which heat to be applied, the dosha involved in disease production, strength and Prakriti of patient and severity of disease.

Sarvanga Sveda

SarvangaSveda (whole body fomentation) is one modality among the methods for SaagniSvedan (fomentation) i.e. with direct application of heat on whole body by various means. Heat generated or applied in Svedan Karma produces heat stress and initiates the thermoregulatory mechanism and produces various hemodynamic changes helps in excretion of metabolic wastes, enhanced immune mechanism.

Niraagni Sveda

In this type of Svedan no external heat is applied but heat loss from the body is checked or heat production in body is increased by advising exercise and other measures like residing in a warm chamber, wearing heavy clothing, excessive (ethanol) drinking, fear, anger, wrestling exposure to sunlight (Charak Samhita Sutrasthana 14/64-65). The measures described under the NiraagniSveda stimulates sympathetic nervous system with release of epinephrine & nor epinephrine that increases BMR which in turn increases heat production, which significantly modulates the core temperature as a response to changing environmental conditions. Thus NiraagniSveda corresponds to adaptive mechanisms of human beings. The causes of vitiation of SvedavahaSrotas are strenuous exercise, rage, exposure to alternate heat and cold, anger, grief, fear etc. All these described causes produce imbalance in heat production and heat loss from the body and alter the sweating mechanism, thus lead to imbalance in functional state of SvedavahaSrotas (Charak Samhita Vimanasthana 5/22).

Benefits of Svedan

Svedan is a procedure which pacifies Vata and Kapha Dosha, reduces Meda (~ visceral fat), relieves stiffness, heaviness and coldness of the body and produce sweating (Charak Samhita Sutrasthana 22/1). It produces various beneficial effects like liquefies the deposited Dosha (Dosha Dravatam), regulated Vata Dosha (Vata Niyamana), flexibility in body parts (Gatra Vinaman), augments metabolism (Agni Deepan), softness of skin (Tvaka Mardava), shining in skin (Tvaka Prasadana), increases appetite (Bhakta Shraddha), clears the channels (Srotosuddhi), removes drowsiness (Nidra-Tandra Nasha), improves joint motility (Sandhi Chesta) helps in removal and pacification of Dosha (Dosha Shodhana).

Indications of Svedan Karma

Svedan is beneficial both in healthy and diseased. When carried out in healthy persons, it promotes the health while in diseased person; it is useful as an independent therapeutic procedure or as a preparation of the patient prior to the Shodhana procedure. In the following diseases Svedan is regarded as an effective treatment.

1. Svedan is useful in cold, cough, hiccough, dyspnoea, hoarseness of voice, spasmodic obstruction in the

throat.

2. Pain and stiffness in the ear, neck and head, sciatica, back, wrist and abdomen, feet, knee, calf. It is beneficial in stiffness, excessive heaviness, numbness and in disease affecting in whole body (Charak Samhita Sutrasthana 14/20; AshtangaHridayamSutrasthana 17/25-26).
3. Paralysis of the face, one limb, whole body or half of the body.
4. Distention of the abdomen, constipation and suppression of urine, dysuria, enlargement of scrotum, disease due to impaired digestion and metabolism.
5. Acharya Sushruta has mentioned some different indications of SvedanChikitsa like it is indicated as Pashchat Karma after the removal of foreign bodies, women who had obstructed delivery without any complications or women who had a normal delivery, while it is indicated as Purva and Pashchat Karma in case of piles, fissure and fistula in ano. (Sushruta Samhita Chikitsasthana 32/17-19)

Contraindications of Svedan Karma

The Svedan involves heating of the body parts; it may aggravate the Pitta Dosha and hence, is harmful in certain weak states of health. For the same reason in specific conditions on which Svedan Karma should be avoided have been mentioned.

1. Those who have taken too much alcohol, obese, thirsty or hungry, pregnant woman.
2. Those who are suffering from Raktapitta (bleeding disorder), Kamala (jaundice), UdaraRoga (abdominal disease), Timira(cataract), diarrhea, diabetes mellitus, and inflammation and prolapsed of the rectum.
3. PaitikaPrakriti individual, person having dry skin, in state of anger or anxiety. The Pitta Prakriti individuals have dominance of Pitta Dosha that leads to more Ushna property (hotness) in them which causes profuse sweating.
4. Weakness, emaciation, OjaKshaya (immune compromised state) and toxic conditions (Charak Samhita Sutrasthana 14/16-19; Sushruta Samhita Chikitsasthana 32/24-25; AshtangaHridayamSutrasthana 17/21-24).

Special precautions

Svedan Karma should not be administered over testicles, heart and eyes. Even if it is very necessary to administer, it should be of mild type (Charak Samhita Sutrasthana 14/10; AshtangaHridayamSutrasthana 17/14) or after covering eye with clean clothes, balls of wheat flour, leaves of Kamala (Nelumbonucifera), Utpala (Nymphaea alba) or Palas (Butea monosperma) and heart should be covered with cool pearl necklace, cool utensils, wet lotus. (Charak Samhita Sutrasthana 14/11-12) The patient should be kept on wholesome diet, should abstain from exercise on that day. (Charak Samhita Sutrasthana 14/67) Since the exercise produces the effects same as off Svedan induced by application of heat. Thus it may produce sign and symptoms of excessive Svedan and complications.

Management of Atisvedya

The treatment of patients suffering from complication due to over fomentation is the same as the summer regimen explain

in the CharakSutrasthana 6th chapter and intake of sweet, unctuous, and cold things in food. (Charak Samhita Sutrasthana 14/15; AshtangaHridayaSutrasthana 17/20) In the treatment of excessive sudation is Stambhan therapy to check the loss of fluid. The sign and symptoms of Atisvedan (excessive sudation) and the principles of management advised by Ayurveda are similar as heat exhaustion and heat stroke as mentioned in contemporary medicine.

Mode of action of Svedan Karma

Under the effects of Svedan Karma on body it has been mentioned that it augments Agni and Pitta Dosha, pacify the Vata and Kaphadosha. Thus, it has regulatory effect over metabolism and restores physiological homeostasis (Sushruta Samhita Chikitsasthana 32/22). The passive heat therapy and Svedan Karma causes increase in body temperature which produces following effects (**Figure 1**):

- Hemodynamic changes
- release of heat shock protein
- release of stress hormone

The medicated Ghrat (Sneha) used for Snehan for internal Snehan and oil for Abhyanga as external Snehan get readily absorbed and reaches into the SukshmaSrotas since it is lipoidal in nature and mechanism of action is same as lipoidal drug delivery system (Singh N et al.,2011; Chaudhary A et al.,2011).

Skin is dwelling site of Bhrajak Pitta Bhrajak Pitta helps in absorption and further metabolism of topical drugs (Sushruta Samhita Sutrasthana 21/10). Heat applied by Svedana enhances the drug absorption by subcutaneous vasodilatation, increasing permeability and enhances the metabolism of the drug by augmenting the Bhrajak Pitta.

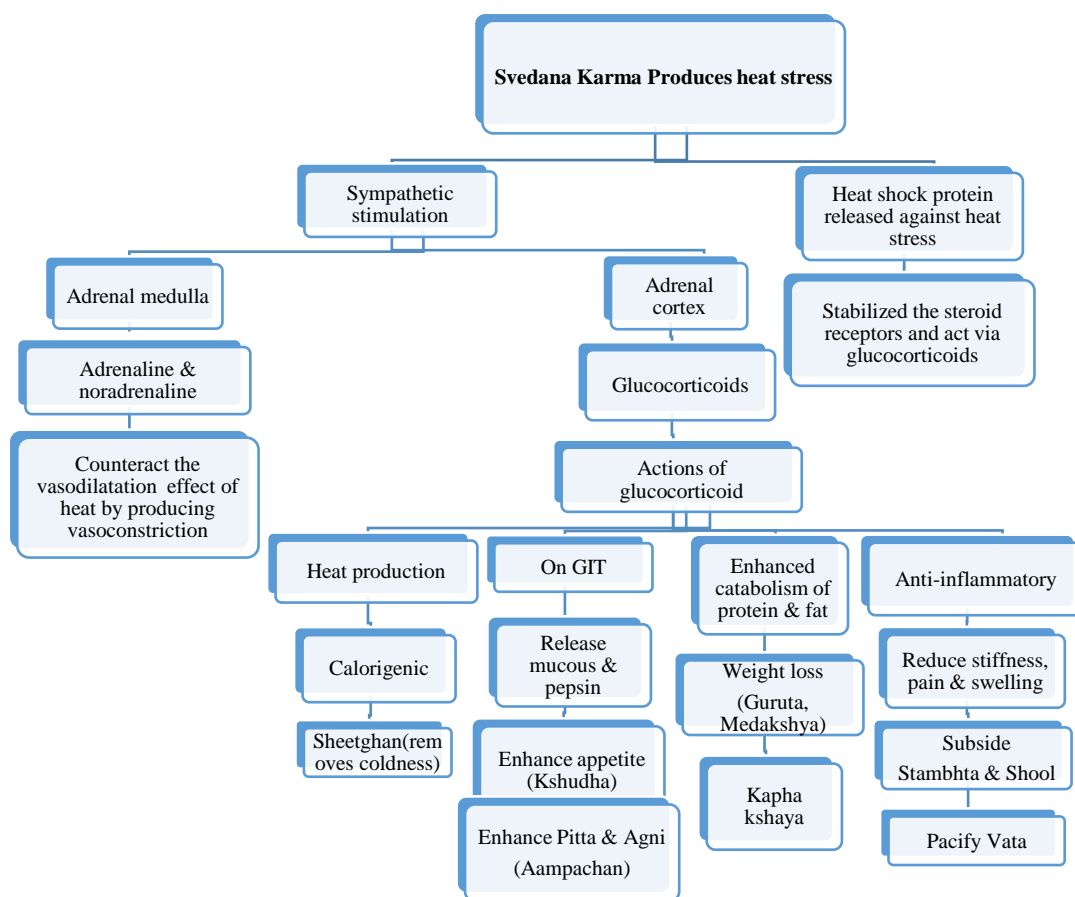


Fig 1.Schematic representation of effect of Svedan

Hemodynamic changes

Various studies have reported the significant changes in BP, PR which signified hemodynamic effects of Svedan Karma (Thomas KN et al., 2017). Under the effects of Svedan Karma on body it has been mentioned that it augments Agni and Pitta Dosha. Thus, it has regulatory effect over metabolism (Sushruta Samhita Chikitsasthana 32/22) and Pitta and Rakta are in a relation of Ashrya-Ashryi that's why Svedan produces

hemodynamic changes (AshtangaHridayaSutrasthana 11/26). Brunt VE, et. al. (2016) found that cardiovascular function and blood pressure were remarkably improved after long-term passive heat therapy (daily hot baths over the course of 8 weeks).

Effect of Svedana karma on Glucocorticoid

Application of heat on the body during Svedana Karma is a

type of physical stress, which increases production of heat shock protein in body that serves to stabilize the unbound glucocorticoid receptors in cytosol. In their inactive state, these receptors exist in the cytosol within a topologically complex assembly of heat shock proteins that serve to stabilize the unbound receptor. The glucocorticoids have myriad actions on the body that are primarily mediated via intracellular receptors. Glucocorticoids passively diffuse through the cellular membrane and bind to these receptors, a process which in turn promotes translocation to the nucleus. Within the nucleus, these ligand-activated receptors then either interact with other transcription factors or bind to specific DNA response elements with a resultant up- or down-regulation in the expression of various genes but the exact mechanism of mode of action is yet not well understood but scientifically it can be said that it has possibly hyperthermic effect which produces haemodynamic changes and via increasing the secretion of glucocorticoid (Charles LR et al., 2003; Andrew HM et al., 2003). K. vangelonaet. al, 2002

reported in their study a significant higher cortisol, adrenaline and noradrenaline values in workers of glass manufacturing unit. So this study also suggests that glucocorticoid production is enhanced after exposure to heat stress.

Possible mechanism of Sarvanga Svedan as Pradhan Karma

Purvakarma procedure includes Snehana and Svedan acts as an adjuvant in Panchkarma therapy and they bring the deeply situated Doshah from Shakha (Dhatu) to Koshtha by Vriddhi and Vishyandana by Snehana and Srotomukha Vishodhan, Paka of doshas by Svedana (Charak Samhita Sutrasthana 28/33). Vaman and Virechana karma then expel the vitiated Dosha from Koshtha to out of the body. Svedan also have Srotoshodhak effect as heat applied during Svedan karma, produces haemodynamic changes like vasodilatation, increase circulation. Which helps in excretion of deposited its waste products in minute Srotas (Sushruta Samhita Chikitsasthana 32/22) (Figure 2)

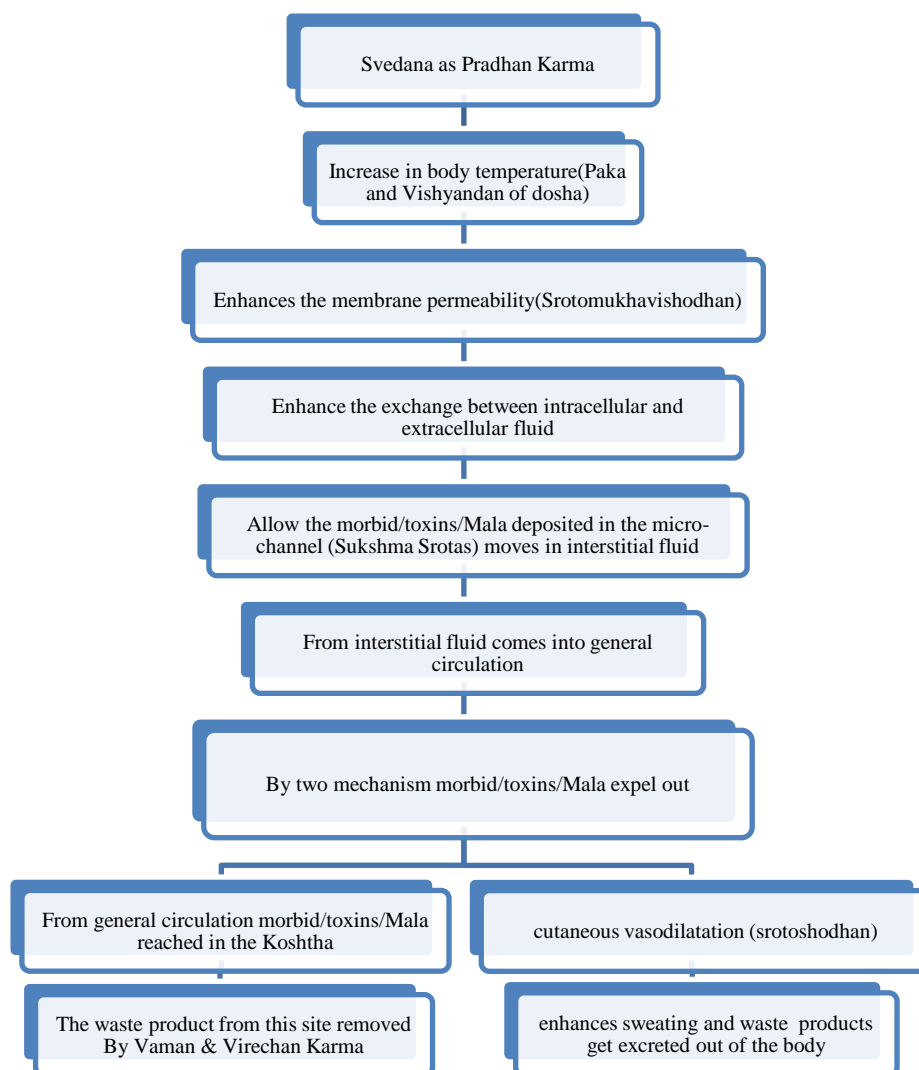


Fig. 2 Schematic presentation of effects of Svedana as Pradhan Karma.

Effect of Svedan Karma on Heat shock protein

The scientists have identified a mechanism that allows cells to adapt their gene expression program to very small changes in temperature. The scientist Florian Hyed suggested that the cellular thermometer is sensitive enough to react to changes in body temperature between 36 to 38°C with altered gene expression. When cells are exposed to heat via various means there is release of protein called HSPs. The HSPs are up regulated intracellular proteins called molecular chaperones that prevent protein aggregations and help transport repair proteins (Walter S. et al., 2002; Buchner J. et al., 2002) while the extracellular HSPs enhance the immune system (Binder RJ et al., 2014).

Recent research studies have suggested various health benefits of HSPs which are released against stress including heat stress eg. Enhanced glucose uptake at skeletal muscle, thermo-protectants, protein synthesis, improved circulation, Anti-inflammatory effect in chronic inflammation associated many disorders, metabolic health (Riezman H et al., 2004; Hooper PL et al., 2009).

Passive heat stress produces significant physiological response and benefits almost same as exercise. The study suggested (Iguchi M et al., 2012) that whole-body heat stress without exercise triggers cardiovascular, hormonal, and extracellular protein responses of exercise. Timely heat stress might serve as adjuvant to training for people who cannot exercise because injuries or disabilities due to injury osteoarthritis aging as needed because of old age injury or chronic disease. The exercise leads to increased body temperature due to increased metabolic rate that leads to sweating and triggers to release chaperones (HSP) and hormones. Ayurveda has considers exercise (Vyayam) under the NiraagniSveda producing the same kind of benefits as mentioned for SaagniSveda. Production of high levels of heat shock proteins triggered by exposure heat and can also triggered by different kinds of environmental stress conditions and water deprivation. As a consequence, the heat shock proteins are also referred to as stress proteins and their up-regulation is sometimes described more generally as part of the stress response (Jesper GS et al., 2003).

Samyak (proper sudation) (Charak Samhita Sutrasthana 14/13; Kashyapa Samhita Sutrasthana 23/13; AshtangaHridayamSutrasthana 17/14; Sushruta Samhita Chikitsasthana 32/23)	Asamyak (improper sudation) (Kashyapa Samhita Sutrasthana 23/16-17; Bhela Samhita Sutrasthana 22/13)	Atisvedan (excessive sudation) (Charak Samhita Sutrasthana 14/14-15; Kashyapa Samhita Sutrasthana 23/13; Bhela Samhita Sutrasthana 22/11; AshtangaHridayamSutrasthana 17/15; Sushruta Samhita Chikitsasthana 32/24)
Remission of sense of cold (<i>Shitoparama</i>), diminution of pain (<i>Shooloparama</i>)	Absence of symptoms indicative of perfect <i>Svedan</i> , persistence of feeling of cold (<i>Sheetata</i>)	Vitiation of <i>Pitta Dosha</i> (<i>Pittakopa</i>), burning sensation (<i>Daha</i>), fainting (<i>Murchha</i>), sense of exhaustion in the body parts (<i>Sharirasadana</i>)
Reduction of stiffness in the body parts (<i>Stambhanigraha</i>), Alleviation of sense of heaviness (<i>Gauravanigraha</i>)	Absence of perspiration (<i>Svedabhava</i>)	weak voice (<i>Swaradaurbalya</i>) reduced tone of the limbs (<i>Angadaurbalya</i>) Pain in the joints (<i>Sandhipeeda</i>) Appearance of black or reddish patches (<i>ShyavaraktamandalaDarshana</i>).
Improvement in the softness of the body parts exposed (<i>Mardava</i>) Appearance of sweating (<i>Svedapradurbhava</i>)	Persistence of feeling of cold (<i>Sheetata</i>)	Appearance of blisters (<i>Sphota</i>) Giddiness (<i>Bhrama</i>) Symptoms indicative of vitiation <i>Rakta</i> (<i>Arshakopa</i>) Excessive thirst (<i>Trishna</i>)
Remission of illness (<i>Rogaprashamana</i>) Desire for cold substances (<i>Sheetasevanechha</i>)	No desire of cold atmosphere (<i>Sheetabhiprayabhava</i>)	General sense of exhaustion (<i>Sadana</i>) Fever (<i>Jvara</i>) Vomiting (<i>Chhardi</i>)

Table: 2 Characteristics of different degree (*Samyak, Asamyak, Atisvedana*) of *Svedan Karma*

Scientific exploration of various effects produced by Svedana Karma**(a) Reduces stiffness (Stambha) and pain (Shula)**

In musculoskeletal disease like rheumatoid arthritis, joint inflammation causes swelling in the joint, which increases when the joint is immobile; these results in limited mobility and tightening of muscles around the joints. Sitting and sleeping for a long time worsen stiffness. Inflammatory substances like cytokines hamper the signaling process of glucocorticoid. Svedana leads to increased body temperature, which produces heat shock proteins and also enhances secretion of glucocorticoids. Thus SamyakSvedana karma (appearance of features as quoted in Samhitas) inhibits inflammatory process by enhancing glucocorticoid activity via

heat shock protein and reduces swelling and pain. Svedan enhances the UshnaGuna in body hence pacify Vata and KaphaDosha which helps in pacifying or reducing Stambha (stiffness), Guruta (heaviness) etc. which have been produced due to deranged Vata and KaphaDosha (Charak Samhita Sutrasthana 2211).

(b) Relieves heaviness (Guruta)

Glucocorticoid increases lipase activity by potentiating actions of other hormones for example growth hormone, catecholamine's, glucagon and thyroid hormone. All these hormones have lipolytic activity. Glucocorticoids favor mobilization of fatty acids from adipose tissues to liver where metabolism of fatty acids inhibits glycolytic enzymes and increases gluconeogenesis. This may be another possible

mechanism via which Svedan help to reduce weight (Jain AK et al., 2009).

(c) Increases appetite (Kshudha)

It enhances the digestive power (Agni). It may be due to increase glucocorticoid activity against heat stress produced in Svedan that enhance the secretion of gastric acid and pepsin. It may be understood as enhanced activity of Pitta & Agni at cellular level (SukshmaSrotas). The entire inflammatory product could be considered as Aam or toxins. The enhanced glucocorticoid activity could be understood as augmentation of Agni at SukshmaSrotas(at cellular level) and vasodilatation causes the increased exchanged between extracellular & intracellular fluid. So it helps in removal of toxins and deposited Kleda in the body i.e. Srotoshodan occurs. In animal experimentation it has been reported that repeated exposure to a mild stress (~40°C) elicits positive mitochondrial adaptation in skeletal muscle comparable to those of exercise. The increased phosphorylation of AMPK and ERE1/2 electron transport and increase of HSP70 and HSP90 by 45% and 38% respectively (Poul SH et al., 2018).

(d) Effect of Svedana on blood vessels

Heat applied in Svedan causes vasodilatation that leads to fall in blood pressure. However this decrease is within physiological limit since the glucocorticoids released against heat stress sensitizes the arterioles to the constrictor action of catecholamines specially nor-adrenaline (Jain AK et al., 2009).

Contraindications of Svedana and glucocorticoids

There are some conditions in which both Svedana Karma and administration of glucocorticoids are contraindicated like hunger, blurred vision, bleeding disorders, epilepsy, in pregnant women etc. So this way we may assume that glucocorticoids released due to heat stress produced by Svedan karma may be involved in various effects produced by Svedana Karma (Tripathi KD et al., 2010).

Features of Ati (excess) Svedan

burning sensation in the body, aggravation of Pitta, fainting (Murcha), heaviness of the body, pain in joints, blisters (Visphota), giddiness (Bhrama), tiredness (Klama), vomiting, thirst (Trshna). All symptoms of Atisvedan are similar to heat exhaustion or stroke. The treatment of patients suffering from complication due to over fomentation is the same as the summer regimen explain in the Charak Sutrasthana 6th chapter and intake of sweet, unctuous, and cold things in food (Charak Samhita Sutrasthana 14/15).

CONCLUSION

Svedana is majorly used procedure out of Shadvidha Chikitsa Upkrama and as Poorvakarma to Panchakarma procedures. The studies on heat stress have shown the similar effects as produced by Svedana karma mentioned in Ayurveda could be taken as evidence to understand the mechanism of action of Svedana karma in relation to heat stress, mitochondrial adaptation, heat shock protein (HSP) and glucocorticoids. Different method of Svedan is based different heat providing media and measures as per disorders. The reason may be that the rate of heat transfer to the body is different in different methods of Svedana Karma. Further scientific research studies could be performed on these parameters to understand various beneficial effect of Svedan Karma as per disorder as well as different type of Svedana Karma.

ACKNOWLEDGEMENTS

Authors are thankful to Department of Kriya Sharir, Faculty of Ayurveda, Institute of Medical sciences, Banaras Hindu University Varanasi.

CONFLICT OF INTEREST

The authors have no conflicting financial interests.

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