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UNDERSTANDING OF ANATOMY AND PHYSIOLOGY OF SHUKRAVAHA SROTAS WSR KLAIBYA

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ABSTRACT

Vajikarana is a one among eight major specialties of the Ashtanga Ayurveda. This subject is concerned with aphrodisiacs, virility and improving health ofprogeny. Even though all factors in Ayurveda are so authentic, the challenges faced by science in the modern day, demands thorough revalidation of the ancient principle and procedures of Ayurveda. It is necessary to make the system more suitable for the modern life. Among the various phases of sexual response the most essential is the achieving of normal erection with sufficient rigidity for penetrative intercourse, the absence of which ends into failure and dissatisfaction. This condition has been elaborately described as 'Klaibya' in Ayurvedic classics and 'Erectile dysfunction' (ED) in modern texts. Sharira, Indriya, Manas, constitute general body and prakruti, all the three being the instruments for self. For the functioning of Manas all the Trigunas, Rajas (stimulation), Tamas (Stability), Satva (Self-determination, control) are essential. The very essential mode of sexual arousal response and act are said to be under the influence of this Triguna model. Any of the basic dysfunctions or disequilibrium of the working mode of either stimulation or stability and self-control is definitely going to hamper the socio-behavioral functioning capacity of an individual with reference to sexuality.

INTRODUCTION

According to Hindu mythology Dharma, Artha, Kaama and Moksha these are the four Purushartha (Pillar) of the life. Ayurveda science adopted this concept. Healthy life is essential for achievement of these Purushartha. After age of Puberty we are bonded for achievement of Kaama(Sexual life).[1]

Erectile dysfunction (ED) or impotence is the repeated inability to get or keep an erection firm enough for sexual intercourse. The word impotence is often used to describe other problems that interfere with sexual intercourse and reproduction such as lack of sexual desire, and problems with ejaculation or orgasm.[2]

Erectile dysfunction is one among sexual dysfunction also known as Impotence, among the various phases of sexual response, the most essential is the achieving of normal erection with sufficient rigidity for penetrative intercourse, the absence of which ends into failure and dissatisfaction. This condition has been elaborately described as *klaibya*[3] *in Ayurveda* classics and 'Erectile dysfunction' in contemporary texts.

Erectile dysfunction or male impotence seems to be a common problem that is faced by the world male population irrespective of race or country. However, precise and exact information of the prevalence of ED is not known (even in a country like the United States). Moreover, how this prevalence varies according to individual characteristics is also not documented in the available literatures.

Male sexual dysfunction affects 10–25% of middle-aged and elderly men. In the National Health and Social Life Survey (NHSLS) the prevalence of sexual dysfunctions was 31%. It is estimated that in 1995 there were over 152 million men worldwide who had erectile dysfunction, and in 2025 the number of men with erectile dysfunction will be 322 million, an increase of nearly 170 million men. The greatest increase will be in the developing world that is, Africa, Asia and South America.[4] A recent estimate of ED is shown to affect over 30 millionUS men to some degree, which probably includes individuals with partial the majority of these individuals probably would be older than 65 years.

Erectile Dysfunction is multifactorial with endothelial, vascular, autonomic, endocrine and neurologic factors either in isolation or in harmony. Erectile.

Dysfunction may result from three basic mechanisms:
(1) Failure to initiate (psychogenic, endocrinal, or neurogenic), (2) Failure to fill (arteriogenic), and (3)

Failure to store adequate blood volume within the lacunar network (venooclusive dysfunction). These categories are not mutually exclusive, and multiple factors contribute to Erectile Dysfunction in many patients.[5]

The person who is having *Maithuna ashaktata* or unable to perform coitus is diagnosed as *klaibya*[6], The disease *klaibya* is a multifactorial condition, mainly involving *Bahu Doshavastha* as a whole and *Shukra dosha* in specific, associated with *Mano Dosha*, *Rasa* and *Shukravaha Sroto Dusthi*.

MATERIALS AND METHODS

Ancient literatures like veda, puranas. The classical ayurveda treatises Charaka Samhita, Sushruta Samhita and Ashtanga Samgraha, etc The classical ayurveda treatises like bhrutrayee's, laghu trayee's and other classical texts etc., different articles related with topic, internet, etc have been explored regarding the concept.

REPRODUCTIVE SYSTEM AND ERECTION

Before approaching to the pathological aspects it is essential to know the physio anatomical aspects for the better understanding of the disease. It is similar for Erectile Dysfunction (*klaibya*) also.

AYURVEDIC VIEW [ANOTOMY]

SHUKRAVAHA SROTAS

Concepts of *srotas* is unique contribution of ayurvedic science. The pathways of transportation of *Dhatu* under metamorphosis are known as srotas. *Vikritis* happening in these srotas can produce disease. All the *Brihatrayis* have mentioned *shukravaha srotas.* Acharyas have differently opined about the *moolasthana* (root) of *shukra*vaha srotas. It can be explained with table as under.

Table no. 1: Showing the moola of *Shukra*vaha Srotas according to *Charaka* and *Sushruta.*

Shukravaha Srotomoola	***C.S.*[7]**	***S.S.*[8]**
Vrishana(bothtesticles)	+	+
Sepha (penis)	+	-
Stanau (both breasts)	-	+

VRISHANA

- The synonyms used for representing testes in the ayurvedic classics with meanings are, Vrishana : " *Vrishati anena iti* " means showering of*shukra*
- *Anda*: since tests are having oval shape.
- *Phala*: Since they contain numerous seeds *mushka*.

They are two in number, while considering the embryonic origin, *Vrishana* is produced from the *sara* of *mamsa, rakta, kapha and medas.*[9] They are suspended outside the body within a sac behind the penis and in between the thighs.

Shepha (Upastha)

In *Ayurveda upastha* is the term used for penis having the synonyms like *Shepha, Shisna, Medhra, Dhvaja etc*. Its normal length is 6 *Angula* and circumference is 5 *Angula*.[10] It is made up of one *Sevani and one Pesi*[11] thus having two muscles in total. In modern anatomy three muscles are considered, may be Sushruta have taken two corpora cavernosa as one Pesi.

The consideration of *Upastha* as *Karmendriya* shows its importance. Further the function *(Karma) Ananda* i.e pleasure attributed to it indicates its psychological importance also in parlance to other *Karmendriyas.*

Charaka[12] and Vagbhata[13] have explained that Shepha works under the influence of Apana Vata and excretes the Shukra and Mutra. Sharangdhara opines that Linga is made with the Kandaras which are connected with Greeva (neck) and Hridaya (heart) & this apparatus is used for Garbhadhana Karma (Impregnate the woman) and also a passage to pass Mutra (urine) and Veerya (semen).[14] Medhra is also considered as Mula of Shukravaha Srotas.[15]

SHUKRADHARA KALA

The functional basement situated at the borders of the different tissues elements and other fundamental functional entities are known as kalas.[16] The seventh i.e the last kala which extends throughout the entire body of living creatures is *shukra*dhara kala.[17] The simile used here is as 'ghee' in the milk' or sugar in the expressed juice of 'sugar cane'. *Shukra* comes out through the ducts situated about two-finger breadth on either side and just below the neck of basti (bladder) and finally flows out through the urinary meatus.[18]

SHUKRAVAHA DHAMANI

They are two pairs of *shukra*vaha dhamani's. *Shukra*pradarbhava and *shukra* visarg are the functions performed by them respectively.[19]

*SHUKRA*VAHA SIRAS

It is one of pair. Erection of penis is resulted due to the filling of these siras with blood and this phenomenon enables to have sexual intercourse.[20]

CONTEMPRORY VIEW

1. The Penis[21]

The penis is a tubular organ through which the distal portion of the urethra passes. It conducts urine to the exterior and introduces semen into the female vagina during sexual intercourse.

The penis is divided into three regions: (1) the root, (2) the body, and (3) the glans.

- The root of the penis is the fixed portion that attaches the penis to the body wall. This connection occurs within the urogenital triangle immediately inferior to the pubic symphysis.
- The body (shaft) of the penis is the tubular, movable portion. Masses of erectile tissue are found within the body.

- The glans of the penis is the expanded distal end that surrounds the external urethral meatus. The neck is the narrow portion of the penis between the shaft and the glans.

The skin overlying the penis resembles that of the scrotum. The dermis contains a layer of smooth muscle, and the underlying loose connective tissue allows the thin skin to move without distorting underlying structures. The subcutaneous layer also contains superficial arteries, veins, and lymphatics.

A fold of skin called the prepuce or foreskin, surrounds the tip of the penis. The prepuce attaches to the relatively narrow neck of the penis and continues over the glans. There are no hair follicles on the opposing surfaces, but preputial glands in the skin of the neck and the inner surface of the prepuce secrete a waxy material known as **smegma**. Unfortunately, smegma can be an excellent nutrient source for bacteria. Mild inflammation and infections in this region are common, especially if the area is not washed thoroughly and frequently. Most of the body of the penis consists of three cylindrical columns of erectile tissue.

In the resting state, the arterial branches are constricted, and the muscular partitions are tense. This combination restricts blood flow into the erectile tissue. The smooth muscles in the arterial walls relax when NO (Nitric oxide) is released, at which time (1) the vessels dilate, (2) blood flow increases, (3) the vascular channels become engorged with blood, and (4) **erection** of the penis occurs.

The flaccid (non erect) penis hangs inferior to the pubic symphysis and anterior to the scrotum, but during erection the penis stiffens and assumes a more upright position. The corpora cavernosa extend along the length of the penis as far as the neck. The erectile tissue within each corpus cavernosum surrounds a central artery. The relatively slender corpus spongiosum surrounds the penile urethra. This erectile body extends from the superficial fascia of the urogenital diaphragm to the tip of the penis, where it expands to form the glans.

ARTERIAL BLOOD SUPPLY

The blood supply to each corpus cavernosum is derived mainly from the internal iliac artery, a branch of the atheroma-prone common iliac artery.

In the pelvis, the internal pudendal artery passes beneath the sacrospinous ligament and over the sacrotuberous ligament, and gives off the perineal artery in Alcock's canal, where it runs under the superficial transverse perineal muscleand the symphysis pubis. After giving off the perineal artery, it becomes the common penile artery. This vessel pierces the pelvic floor adjacent to theinferior ramus of the ischium near the bulb of the urethra and gives off the bulbar, urethral, dorsal and cavernosal branches before reaching the corpus cavernosum to form one element of the paired dorsal arteries.

The cavernosal artery on each side pierces the tunica albuginea at the hilum of the penis. It then runs distally in the center of each corpus while giving off numerous helicine branches. These cork screw shaped muscular vessels open directly into the lacunar spaces.

The tonic contraction of the smooth muscle walls normally allows only small amounts of blood into the lacunar spaces, thereby maintaining penile flaccidity. Relaxation of the muscular walls of these vessels initiates the hemodynamic changes that result in penile erection.

Figure 2: ARTERIAL SUPPLY TO THE PENIS.

VENOUS DRAINAGE

Blood leaves the penis via three venous systems:

- Superficial,
- Intermediate, and
- Deep.

The superficial system allows blood from multiple superficial veins to drain into the superficial dorsal vein, which itself drains into the left external branch of the internal saphenous vein.

The intermediate venous system lies beneath Buck's fascia and comprises the deep dorsal vein and the multiple circumflex veins. This system drains blood from the glans, corpus spongiosum and the distal two-thirds of the corpora.

The deep dorsal vein runs in the groove dorsally between the corpora cavernosa. It enters the pelvis beneath the suspensory ligament, which suspends the corpora from the undersurface of the pubic arch and drains into the dorsal venous complex at the urethroprostatic junction.

The deep drainage system consists of the cavernosal and crural veins. Emissary veins in the proximal third of the penis join to form one or two cavernosal veins which pass between the bulb and crust of the penis to drain into the internal pudendal vein

LYMPHATIC DRAINAGE

Lymph is drained from the penis by lymphatics which pass to the superficial and deep inguinal lymph nodes of the femoral triangle. In turn, these nodes, which may become secondarily involved in patients who have carcinoma of the penis, drain to the external and internal iliac lymphatic chains. Conditions that obstruct these lymphatic channels, such as metastatic prostate cancer, may resultin gross penile and scrotal edema.

STRUCTURE OF THE TESTES

Each testis has the shape of a flattened egg that is roughly 5 cm (2 in.) long, 3 cm (1.2 in.) wide, and 2.5 cm (1 in.) thick. Each has a weight of 10-15 g (0.35-0.53 oz). The testes hang within the scrotum, a fleshy pouch suspended inferiorto the perineum, anterior to the

anus and posterior to the base of the penis.

Deep to the tunica vaginalis covering the testis lies the tunica albuginea, a dense layer of connective tissue rich in collagen fibers. The fibers of this network are continuous with those surrounding the adjacent epididymis. The collagen fibers of the tunica albuginea also extend into the substance of the testis, forming fibrous partitions, or septa. These septa converge toward the area closest to the entrance of the epididymis. This region, located at the superior end of the testis, is called the mediastinum of the testis (or mediastinum testis). The connective tissues in this region support the blood vessels and lymphatic that supplies the testis and the efferent ducts, which transport sperm to the epididymis.

NEUROANATOMY

Three sets of peripheral nerves are involved in penile erection and subsequentdetumescence:

- Sympathetic nerves from the tenth thoracic to the second lumbar(T10–L2) thoracolumbar outflow
- Parasympathetic nerves from the second to fourth sacral (S2–S4)segments,
- Somatic fibers via the pudendal nerves.

a) The sympathetic nerves reach the corpora, as well as the prostate and bladder neck, via the hypogastric nerves, where they are susceptible to injury in retroperitoneal lymph node dissection performed for the treatment of metastatic testicular cancer. Postganglionic noradrenergic fibers pass postero lateral to the prostate in the so-called nerves of Walsh to enter the corpora cavernosa medially.

b) Parasympathetic nerves stem from the so-called sacral erection center and their cell bodies lie in the inter medio lateral nuclei from S2 to S4. Exiting through the sacral foramina, these nerves pass forward lateral to the rectum as the Nervi erigentes to reach the pelvic plexus. In this location, preganglionic fibers relay in ganglia, and postganglionic nonadrenergic noncholinergic (NANC) fibers pass in the cavernous nerves to the corpora cavernosa.

c) The pudendal nerves comprise motor efferent and sensory afferent fibers which innervate the ischiocavernosus and bulbocavernosus muscles as well as the penile and perineal skin. Pudendal motor neuron cell bodies are located in Onuf's nucleus of the S2–S4 segments. The dorsal nerve of the penis emerges as the last branch of the pudendal nerve. It then runs distally along the dorsal penile shaft lateral to the dorsal artery. Multiple fascicles fan out distally, supplying proprioceptive and sensory nerve terminals to the dorsum of the tunica albuginea and skin of the penileshaft and glans penis.

CENTRAL NERVOUS SYSTEM AND PENILE ERECTION

Although reflex spinal erections may occur provided that the sacral reflexes are intact (for example, after cervical or thoracic spinal injury), central connections are paramount in engendering the normal male sexual response. These central pathways, however, are as yet incompletely understood.

A number of areas in the brain are involved in the modulation of erection, including-

- ✓ The thalamic nuclei,
- ✓ Rhinencephalon,
- ✓ Limbic structures and
- ✓ Paraventricular nucleus.

Messages are integrated in the medial preoptic area where dopaminergic neurons are important. Norepinephrine (noradrenaline) and serotonin have also been identified as neurotransmitters in this region.

Efferent pathways enter the medial forebrain bundle and pass caudally into the mid-brain segmental region near the lateral part of the substantia nigra. Caudal to the mid-brain, the efferent pathway travels in the ventrolateral part of the pons and medulla, passing down to the sacral spinal centers via the lateral funiculus of the spinal cord.

Activation of the parasympathetic neurons, located in the spinal cord, leads to intrapenile release of nitric oxide, mainly by neural terminations. Superimposed on this hypothalamo-spinal circuit are higher centers, including the gyrus rectus, cingulate gyrus and hippocampus; these areas are all capable of modifying the erectile response, although their exact function has not yet been elucidated.

Diseases specifically affecting these structures include Parkinson's disease, multiple system atrophy and stroke, all of which are often associated with erectile dysfunction.

PHYSIOLOGY OF ERECTION

Ayurvedic View

The performance of sexual act depends upon physical and psychological excitement which is proportional to the strength of the body and mind.[114]

Male sexual act mainly comprises of two phase i.e. erection and ejaculation. Erection is the prerequisite to accomplish the sexual act, and it is attained in three ways individually or combined together - viz –

- *Sankalpa* (Mental preparation for sexual act),
- *Chesta* (physical stimulation) and
- *Nishpidana* (Localized rubbing or stimulation).[22]

Sankalpa indicates involvement of psyche as a prime factor and the stimulation of which is obtained through the various pleasuring objects of different sense organs such as *Darshana, Sravana, Rasana, Ghrana, and Sparshana*. Further *Sparshana* is the most important as it is the media in *Chesta* and *Nishpidana* for attaining and maintaining the erection and ejaculation. Various objects of different senses stimulating the mind for getting erection and indulging in sexual intercourse are described in the classical texts.[23]

The involvement of different sense organs in their respective subjects, then the stimulation of the mind and *Chesta* and *Nishpidana* all depends upon the normal function of *Vata*. Particularly *Prana*, *Vyana* and *Apana* are responsible for erection and ejaculation of semen.[24,25,26]

It will be surprised to know that *Acharya Sushruta* was the first person who described the complex psycho - neuro - vascular mechanism of erection. He says that the filling of *Shukra*vaha Shira under the influence of psychological or physical stimulation results in tumescence.[27]

The ejaculation of *Shukra* is due to the psychological (*Smarana*), visual (*Darshana*), Auditory (*Sravan*) and Tactile (*Sparshana*) stimulation.[28]

Foregoing description indicates the involvement of complex psycho-neuro- vascular mechanism in the process of penile erection.

SHUKRA

The term *Shukra* has got a very wider concept in Ayurveda. A careful appraisal of the concept of *Shukra* is propounded by the classical Ayurvedic texts suggest that though the term *Shukra*, *Veerya* and *Retas* are generally used as synonyms and more or less used to denote semen, sperm or androgen hormones.

The physical characteristics of Phalavata *Shukra are Bahala (*Thick*), Madhura (*Sweet*), Snigdha (*unctuous*), Avisra (*Devoid of bad smell*), Guru (*heavy*), Picchila (*slimy*), Shukla (*white - milky*) and Bahu (*abundant*)* denotes semen or seminal fluid.[29]

The *Prasadamsa* of *Shukra* is responsible for the conception,[30] denotes spermatozoa which carries all-the genetic characteristics of the individual. The other functions attributed to *Shukra* are *Harsha* (Pleasure or desire), *Preeti* (affection), *Chyavana* and *Dhairya* (confidence in difficult situation and in performing sexual intercourse), and *Dehabala* (strength of the body) which depends upon the psychological and physical well being of sexual behavior.

Hence it refers to the Androgenic hormones, as they maintain the normal sexual behaviors of the individual.

From the foregoing, it appears that *Shukra* includes seminal fluid, spermatozoa, androgenic hormones etc.

MODERN VIEW

Penile erection depends on the complex psycho-neuro-vascular events and intact hypothalamus- pituitary-testicular axis. Various events that are taking place during erection of the penis are explained hereunder:

HEMODYNAMICS AND MECHANISM OF ERECTION

The penile erectile tissue, specifically the cavernous smooth musculature and the smooth muscle of the arteriolar and arterial wall, plays a key role in the erectile process.

ARTERIAL DYNAMICS

- In the flaccid state, sympathetic influence dominates the terminal arterioles and sinusoidal smooth muscles are contracted and a minimal amount of blood flow through the sinusoidal spaces mainly for nutritional purposes.
- Following sexual stimulation there is a parasympathetic overdrive and release of neurotransmitters from the cavernous nerve terminals causing relaxation of the smooth muscle in the terminal arterioles and the trabecular leading to decrease in the peripheral resistance.
- This causes dilation of the arterioles and arteries by the increased blood flow in both the diastolic and systolic phases. The relaxed trabecular smooth musculature markedly increases the compliance of the sinusoids which are then able to retain the incoming blood and causes the elongation, expansion and erection of the penis.
- When full erection is reached, the flow through the cavernous artery decreases as the intracavernous pressure rises to about 10-20 mm Hg below the systolic blood pressure.
- In the glans penis and corpus spongiosum the blood flow continues to be much higher than that of the flaccid state.[31]

VENOUS DYNAMICS

During erection the arterioles are dilated, the sinusoids are distended causing compression of the subtunical venular plexus between the distended sinusoidal wall and relatively indispensable Tunica albuginea thus effectively reducing the venous outflow.

The further engorgement during the rigid phase of erection causes uneven stretching of the layers of the Tunica albuginea. That closes off most of the emissary veins between its inner and outer layer causing venous outflow to a minimum and changes the corpus cavernosum to an almost completely closed system.

In case of corpus spongiosum and glans penis due to the thin covering of Tunica albuginea there is a minimal venous occlusion leading to reduced pressure to 1/3 or 1/2 of corpora cavernosa.

During the full erection phase, partial compression of the deep dorsal and circumflex vein between Buck's fascia and the engorged corpora cavernosa contribute to glanular tumescence, although the spongiosum and glans essentially function as a large arteriovenous shunt during this phase.

In the rigid erection phase the spongiosum and penile veins are forcefully compressed by the lschiocavernosus and bulbo cavernosus muscles resulting in further engorgement and increased pressure in glans and spongiosum.

PHASES OF PENILE ERECTION

To summarize the hemodynamic events of erection and detumescence it isdivided into seven phases:

Flaccid phase

Minimal flow through the cavernous artery to the sinusoids for nutritional purposes. The intracorporeal blood gas values are identical to those of venous blood. Duplex utlrasonography shows an average inner diameter of 0.05 cm. in the proximal cavernous artery and peak flow velocity of 15 cm/sec. or less.

Latent or filling phase

The blood flow is highest in this phase. There is increased blood flow through the internal pudendal and cavernous arteries during the systolic and diastolic phases. The penis elongates without change in the intracavernous pressure in a healthy potent man, the inner diameter of the proximal cavernous artery dilates to 0.1 cm. with a peak flow velocity of over 30 cm/sec. and forceful pulsation ofthe cavernous arteries.

Tumescence Phase

Intracavernous pressure increases rapidly and the blood flow start to decrease. The penis expands and elongates to its maximal capacity. After the intracavernous pressure rises above the diastolic pressure, inflow occurs only during the systolic phase. Duplex ultrasound shows a decreased inner diameter, sharper and shorter systolic wave form, and absence of diastolic flow.

Full erection phase

The intracavernous pressure becomes steady and reaches about 90% of the systolic pressure. The flow in the pudendal artery is lower than in the tumescence phase, but higher than it in the flaccid phase. Duplex ultrasound shows that the systolic wave form is slower than earlier phases with reverse of diastolic wave form. In men with healthy arteries, concentric pulsation with noticeable change of arterial diameter between the systolic and diastolic phases can be seen clearly. Intracavernous blood gases now reach the arterial blood gasvalue.

Rigid or skeletal erection phase

Owing to the contraction of the ischiocavernous muscle, the intracavernous pressure rises well above the systolic pressure, resulting in rigid erection. During this phase there is no inflow of blood, its short duration due to skeletal muscle fatigue prevents ischaemia and tissue damage.

Initial detumescence phase

A small and transient increase of intracavernous pressure is common in the initial detumescence phase. This phase is abolished by clamping of the aorta, yet enhanced by stimulation of the sympathetic trunk indicating continuing arterial flow as in the full erection phase and beginning smooth muscle contraction against a closed venous system.

Slow detumescence phase

This phase is noted by a slow decline of intracavernous pressure indicating slow reopening of the venous channels with decreasing arterial flow. This phase is abolished by sympathetic stimulation.

Fast detumescence Phase

There is a fast decline of intracavernous pressure with fully restored venous outflow capacity. The arterial flow returns to its prestimulation level.

In summary, penile erection is a result of relaxation of the intracorporeal smooth muscle and increase in (I) arterial flow, (II) venous resistance, (III) compliance of sinusoids, where as detumescence occurs when these processes are reversed.

NEUROPHYSIOLOGY OF PENILE ERECTION

Peripheral Pathways

The innervation of the Penis is both autonomic (sympathetic and parasympathetic) and somatic (sensory and motor).

- The sympathetic and parasympathetic nerves merge to form the cavernous nerves, which enters the corpora cavernosa and corpus spongiosum to affect the neurovascular events during erection and detumescence.
- Somatic nerves are primarily responsible for sensation and the contraction of Bulbocavernosus and ischiocavernosus muscles.

Autonomic Pathways

The sympathetic pathway originates from T11-L2 spinal segments and passes via the white rami to the sympathetic chain ganglia.

In man, T10-T12 segments are most often the origin of the sympathetic fibres, and the chain ganglia cells projecting to the penis are located in the sacral and caudal ganglia.[32]

The parasympathetic pathway arises from neurons in the intermediolateral cell columns of the S2-S4 segments of spinal cord. The preganglionic fibres pass in the pelvic nerves to the pelvic plexus, where they are joined by the sympathetic nerves from the superior hypogastric plexus.

The cavernous nerves are branches of the pelvic plexus that innervate the penis. A clear understanding of the course of these nerves is essential to prevent latrogenic erectile dysfunction.

Stimulation of the pelvic plexus and the cavernous nerves induces erection, whereas stimulation of the

hypogastric nerve or the sympathetic trunk causes detumescence. This clearly implies that the sacral parasympathetic input isresponsible for tumescence by relaxing the intracorporeal smooth muscle and the thoracolumbar sympathetic pathway controls detumescence by contracting intracorporeal smooth muscles.

In many patients with sacral spinal cord injury retain psychogenic erectile ability even though reflexogenic erection is abolished. These cerebrally elicited erections are found more frequently in patients with LMN lesions below T12.[33] No psychogenic erection occurs in patients with lesion above T9. The efferent sympathetic outflow is thus suggested to be at T11-T12.[34]

These authors have also reported that in patients with psychogenic erections, lengthening and swelling of the penis are observed, but rigidity is insufficient. It is therefore possible that cerebral impulses normally travel through sympathetic (inhibiting norepinephrine release), para sympathetic (releasing NO and acetylcholine) and somatic (releasing acetylcholine) pathways to produce a normal rigid erection.

Somatic Pathways

The somatosensory pathway originates at the sensory receptors in the penile skin, glans, urethra and corpus cavernosum. In the human glans penis, there are numerous afferent terminations i.e. free nerve endings and corpuscular receptorswith a ratio of 10:1.

The nerve fibres from the receptors converge to form bundles of the dorsal nerve of the penis which joins other nerves to become the pudendal nerve. Activation of these sensory receptors sends messages of Pain, temperature and touch via dorsal and pudendal nerves, spinal cord and spinothalamic tract to the thalamus and sensory cortex for sensory perception.

The dorsal nerve is a mixed nerve with both somatic and autonomic components that enable it to regulate both erectile and ejaculatory functions. Onuf's nucleus in the S2-S4 spinal segments is the centre of somatomotor penile innervation. These nerves travel in the sacral nerves to the pudendal nerve to innervate the ischiocavernosus and bulbocavernosus muscles. Contraction of the ischiocavernosus muscle produces the rigid erection phase. Rhythmic contraction of the bulbocavernous muscle is necessary for ejaculation.

Supraspinal Pathways

Anterior part of the cingulate gyrus, median preoptic area (MPOA), the paraventricular nucleus of the hypothalamus, lateral hypothalamus and tegmentum are important integration centers for sexual drive and penile erection.[35] Electro stimulation of these areas induces erection and lesion of these sites limits copulation. Efferent pathways from the MPOA enter the medial fore brain bundle and the mid brain segmental region.

In summary the structures listed earlier are responsible for the three types of erection, i.e.

- ✓ Psychogenic,
- ✓ Reflexogenic and
- ✓ Nocturnal.

Psychogenic erection is a result of audiovisual stimuli or fantasy. Impulses from the brain modulate the spinal erection centres (T11-T12 and S2-S4) to activate the erectile process. In some cases psychogenic erection is possible even when one out of two spinal erection centres is intact.

Reflexogenic erection is produced by tactile stimuli to the genital organs. The impulses reaches the spinal erection centres, some then follow the ascending tract, resulting in sensory perception and other activate the autonomous nuclei to send messages via the cavernous nerves to the penis to induce erection. This type of erection is preserved in patients with upper spinal cord injury.

a) Nocturnal erection occurs mostly during the phases with rapid-eye movement (REM) sleep and relatively high dominant frequencies in the electroencephalogram.
b) The mechanism is as yet unknown, whether the sleep erection uses both the sympathetic and the parasympathetic pathways or only one of the two. The mechanisms within the CNS are entirely unknown. But the central mechanism must be different for sleep erection and psychogenic erection.
c) So it is possible that genetic, toxic or infective factors could damage the central mechanism by which sexual thoughts causes erection and yet cause no impairment of sleep erection.
d) The normal sleep erection proves that their peripheral mechanism both neural and vascular are intact, but do not prove the absence of a relevant organic disorder within the CNS. Hence in patients with normal sleep erection should not be assumed dogmatically that they are only suffering with psychogenic erectile dysfunctions though it is correct in some cases.

ROLE OF NEUROTRANSMITTERS INVOLVED IN ERECTION ANDDETUMESCENCE

Nitric oxide (NO) is the most important neurotransmitter in the mechanism of erection. NO is synthesized from endogenous Larginine by Nitric Oxide Synthase (NOS) located in the vascular endothelium.[36]

NO may be synthesized and released as a neurotransmitter by the nonadrenergic noncholinergic (NANC) neurons after they are excited by either electrical or chemical stimulation.

The other possible neurotransmitter responsible for penile erection includes Acetylcholine (Ach), Vasoactive intestinal polypeptide (VIP), Calcitonin gene related peptide (CGRP), Substance P (SP), Dopamine, 5 Hydroxytryptamine-1c receptor (5HT),[35] peptide

histidine methionine, pituitary adenylate cyclase - activating poly peptide.

The possible detumescence neuro transmitters are noradrenaline, neuropeptide Y (NPY) endothelium thromboxane A2, prostaglandin f2x leukotrienes, 5, Hydroxytryptamine - 1A receptor agonist.

ROLE OF HYPOTHALAMO-PITUITARY-TESTICULAR (HPT) AXIS

Intact HPT axis is essential for the normal sexual functioning and the spermatogenesis. The Endocrine functions of the testicles involve a complex finely regulated interaction between the CNS, Anterior Pituitary and the Testis. Hypothalamus forms the most important part of the axis in the CNS secreting Gonadotrophin releasing hormone (GnRH), which stimulates pituitory production of LH and FSH which inturn stimulate, the testis. Testis contains two functionally distinct components each of which subserves a different role.

1) The seminiferous tubules which house the Sertoli cells and spermatogonia and their function is to produce spermatozoa.
2) The Leydig or interstitial cells produce and secrete sex steroids, notably testosterone and to a lesser extent oestradiol.

Testosterone is responsible for the initiation, development and maintainance of primary and secondary sexual characteristics - as well displaying a role in normal male sexual behavior and potency. Testosterone also has an intratesticular paracrine role in the initiation and maintainance of spermatogenesis. It is important to note that the secretion of GnRH is under the influence of central catecholamines and neuropeptides, including opioids.

Although it is recognised that low circulatory testosterone level adversely affect the whole gamut of male sexual behavior (Libido, sexual thoughts and fantasies, potency), the precise mechanism whereby androgens exert these effects are largely unknown. However hypogonadal males receiving replacement treatment with intramuscular testosterone preparation usually describe peak erectile responsiveness as occuring 2-6 days after injection.

CONCLUSION

The entire body is seat of Manas and Shukra and Hrudaya is the pivotal organ for regulation of rasa, Shukra, Ojas, Manas and Vayu. Hence all psychosexo endocrinal functions are interdependent. The Harsha-Sexual excitement is dependent on Dehabala (psychological integrity) and also the Vrushattva-Sexual capacity depends upon this excitement and this triangular Harsha-Dehabala- Sattvabala-Vrushattva. HDSY axis in not constant.

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