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Review of *Jala*

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Abstract

Ayurveda is one of the most ancient and elaborate medical science possessing rich heritages of practical knowledge. *Sharir Rachna* is described in our classics covering different aspects like structures, location, composition and their numbers, macroscopic and microscopic details. Detailed knowledge of *sharir Rachna* is must for every physician for being skilled in medical practice. Facts described in our *Samhitas* are true & authentic but some of the facts are described very briefly. *Jala* is one those topics which needs to be elaborated. To reveal facts about *Jala,* this study is undertaken. *Jala* means a network like structure. There are four type of *Jala* i.e., *Mansa Jala, Sira Jala*. *Snayu Jala* and *Asthi Jala*. Each are four in number and total 16 *Jala* in human body are said to be situated in *Manibandha* and *Gulpha*. Wrist and Ankle region has similarity with *Manibandha* and *Gulpha*. Many Muscle, Tendons, Artery, Vein, Nerves, Fascia, Ligament and Bones are compactly arranged at Wrist and Ankle. All these structures can be included separately under the heading Muscular network, Neurovascular network, Ligamentous network and Bony network. Numerous structures are compactly arranged such that they are interwoven but well demarcated too. Every specialized function needs anatomical specialty and every anatomical specialty results into some different physiological outcome. Here *Jala* provides a complex configuration to *Manibandha* and *Gulpha.* This complexity is basis for many physiological attributes like stability, strength, higher degree of controlled movements and its vulnerability to injury. *Jala* makes*Manibandha* and *Gulpha* an anatomically potent structure.

Keywords

Ayurveda, Sharir sthan, Jala,Manibandha, Gulpha

Greentree Group

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INTRODUCTION

Description of *Jala* is available in Agni Purana[1], Susruta Samhita[2], Ashtanga Sangraha[3], Ashtanga Hridaya[4], Sharangadhar Samhita[5] and Bhavprakash[6]. All of the above texts quotethe same thing about *Jala*that-

I. *Jala* are sixteen in number

II. *Jala* are situated over the region of *Manibandha* and *Gulpha*

III. There are four type of *Jala* i.e. *MansaJala*, *SiraJala*, *SnayuJala* and *AsthiJala*. Each of them is four in number. These *are paraspar nibaddha* , *paraspar sanshlishta* and *paraspar gavakshita*at *Manibandha* and *Gulpha*.This mean they are continuous, compactly arranged, intermingled having some spaces in between.

To explore all the aspects of *Jala*, we have to understand what is meaning of *Jala*, what are the possible structures which can be counted under the term *Mansa*, *Sira*, *Snayu* and *Asthi* then what *MansaJala*, *SiraJala*, *SnayuJala* and *AsthiJala* mean with reference to *Manibandha* and *Gulpha*. This study includes Ayurvedic review of literature of *Jala, Mansa, Sira, Snayu, Asthi, Manibandha* and *Gulpha.* To understand its modern counterpart, modern anatomical review of literature of Wrist and Ankle is also included.

The word *Jala* literally mean network. Other meanings of *Jala* available are window[7], dense braches[8],net or window lattice[9], collection or group[10], plexus or interlacing decussation[11]. Synonyms of *Jala* indicate towards complexity, presence of higher number of structure and its branches, compact arrangement and instead of all this well differentiate and independent from each other.*Mansa* or *MansaDhatu* is one of the seven *Dhatu* present in our body.*Peshi*s are formed from *MansaDhatu* through the process of *Paka*. Pittayukta vayu enters the *MansaDhatu* and divides it into *Peshi*s[12].*Peshi* are made up from*MansaDhatu* and represents *MansaDhatu* in our body. In different context *Mansa* and *Peshi* are used as synonym owing to morphological, structural and functional relationship. In context of modern anatomical science *MansaDhatu* is equivalent to Muscular tissue and term *Peshi* is used commonly to denote Muscular structures(muscle and tendon). Mostly the shape of *Peshi*s arerope like threads being thick in its center with white glistening ends called *Kandara*wich is equivalent to tendon[13]. *Peshi* are made up of *MansaDhatu*

merging into *Snayu*[14]. Acharya Chakrapani explained enlarged and thickened*Snayu* as *Kandara*[15]. So *Kandara* can be included either in *Peshi* or *Snayu*.Here *Peshi* can be said as muscles including theirtendon. So under the heading *Mansa,* muscle bellies and muscle tendons will be included.Acoording to *vyutpatti*,*Sira* are channels which keeps sluggish flow of liquids of the body. Normally we mean vein from word *Sira.* Term *Sira* is is most variably used under different references and in different meanings. Many references quote*Sira*as different structuresother than vein. References are also available quoting *Sira* as Artery[16], Nerve[17] (nimeshini *Sira*), *Kandara*[18], Lacrimal duct[19] (*Jala*vahini *Sira*), Lactiferous duct[20](kshiravahi *Sira*), semen carrying ducts(viryavahi sira). Here in context of *Jala,* we will include artery, veins and nerves with their branchesunder the term *Sira*.*Snayu* is strong white fibrous *Updhatu* of the body which is binder of muscle, bones, fat and joints[21].*Snayu* takes origin from *kharapaka* of *meda*[22]. Term *Snayu* is used in two meanings- *Snayusamhati* and *Snayuvyakti*.*Snayusamhati* means compages(bunch) of fibres of *Snayu* where *Snayuvyakti* mean to individual *Snayu* fibres. *Snayu*samhati are mainly used in binding of bony joints of the body[23].Out of four kinds of snayu, bony joints of limbs are strengthened by the *Pratanvati Snayu*. *Snayu*sanhati is considered as ligament and *Snayu*vyakti as Fascia,tendon,vulvular band of fibrous tissue etc. Here under the term *Snayu,* ligaments, fascia will be studied.*Asthi* is hard, supportive and stable element of human body which provides structural support to the body and nourishes majja[24].When meda dries up extremely through *Paka* by its *agni*, then it is called *Asthi*[25]. Under the heading *Asthi,* bones will be studied. Region between forearm and hand which is protuberated and commonely used to wear ornaments is called *Manibandha*[26].*Manibandha* is a *rujakar* and *sandhi marma*having two *angulapramana*.*Manibandha* region is twelve *angula* in circumference..Gulfa is name for protuberated structure situated at lower end of leg[27]. *Gulpha* marma is a rujakar and sandhi marma having two *angula pramana*. *Gulpha* region is fourteen *angula* in circumference.

Jala means plexus, group, network or interlacing decussation. We will study muscle tendons and muscle bellies under the term '*Mansa*'. Artery, Vein and Nerves will

be studied under the term‘*Sira*’. Ligaments, fibrous tissue and thickening of deep fascia like retinaculumwill be includedunder the term‘*Snayu*’ and bones under the term ‘*Asthi’*.Wrist region will be studied under the heading*Manibandha*. Wrist or carpus is composed of eight carpal bones which are arranged in proximal and distal row and each contains four bones. Wrist region extends radiocarpal joint to carpometacarpal joints. Ankle region will be studied under the term *Gulpha.*We will include tarsus with Ankle joint collectively as Ankle region.Muscle tendons and muscle bellies of Wrist and Ankle region will be counted under ‘MuscularNetwork’ or ‘*MansaJala*’. Network formed by artery, vein and nerves Wrist and Ankle region will be included under the term ‘*SiraJala*’ or ‘NeurovascularNetwork’. Networkformed by Ligaments, Fibrous tissue and thickening of deep fascia like retinaculum of Wrist and Ankle region will be included under the term ‘*SnayuJala*’ or ‘ LigamentousNetwork’.Network formed by these bones of Wrist and Ankle region will be included under the term ‘*AsthiJala*’ or ‘ BonyNetwork’.

After undergoing review of anatomy of *Manibandha* and *Gulpha*(Wrist and Ankle region) through modern anatomical literature, following are the observed structuresunder the heading of *MansaJala*, *SiraJala*, *SnayuJala* and *AsthiJala*[28,29].

TYPE OF NETWORK	**STRUCTURES IN *MANIBANDHA***	**STRUCTURES IN *GULPHA***
***MANSA JALA* (*MUSCULAR NETWORK*)** Including muscle tendon and muscle bellies	**TENDONS**	**TENDONS**
	Flexor carpi radialis	Tibialis anterior
	Palmaris longus	Extensor hallucis longus
	Flexor carpi ulnaris	Extensor digitorum longus
	Flexor digitorum superficialis	Peronius tertius
	Flexor digitorum profundus	Ext. digitorum brevis
	Flexor pollicis longus	Gastronemius
	Pronator quadrates	Soleus
	Brachioradialis	Plantaris
	Extensor carpi radialis longus	Flexor hallucis longus
	Extensor carpi radialis brevis	Flexor digitorum longus
	Extensor digitorum	Tibialis posterior
	Extensor digiti minimi	Peroneus longus

	Extensor carpi ulnaris	Peroneus brevis
	Abductor pollicis longus	
	Extensor pollicis brevis	
	Extensor pollicis longus	
	Extensor indicis	
	MUSCLES	
	Abductor pollicis brevis	
	Flexor pollicis brevis	
	Opponens pollicis	
	Palmaris brevis	
	Adductor digiti minimi	
	Flexor digiti minimi	
	Opponens digiti minimi	
TYPE OF NETWORK	**STRUCTURES IN *MANIBANDHA***	**STRUCTURES IN *GULPHA***
NEUROVASCULAR NETWORK (*SIRA JALA*) Including arteries, vein and nerves	Radial artery	Anterior tibial artery
	Palmar carpal branch of radial artery	Anterior medial malleolar artery
	Superficial palmar branch of radial artery	Anterior lateral malleolar artery
	Dorsal carpal branch of radial radial artery	Medial malleolar Network
	Ulnar artery with branches • Palmar carpal branch • Dorsal carpal branch • Deep palmar branch	Lateral malleolar Network
		Dorsal artery of foot
		Posterior tibial artery
		Peroneal artery with branches • Perfarating • calcaneal
	Superficial palmar arch	
	Anterior interosseous and posterior onterosseous artery	
	Median artery(occasionally present)	Medial malleolar branch
	Cephalic vein	Calcanean branches
	Basilic vein	Medial plantar artery
	Median anterbrachial vein	Great saphenous vein
	Deep vein (vena commitants)	Small saphenous vein
	Lateral cutaneous nerve of the forearm	Dorsal venous Network
	Medial cutaneous nerve of the	Anterior tibial veins

	forearm with its anterior and posterior branch	
	Median nerve with anterior interosseous branch and palmar cutaneous branch	Posterior tibial vein
	Ulnar nerve with palmar cutaneous ,dorsal and superficial terminal branch	Saphenous nerve
		Tibial nerve with branches • Articular • Sural • calcanean
		Deep peroneal nerve with lateral terminal and medial terminal branch
		Superficial peroneal nerve with cutaneous, medial and lateral branches

TYPE OF NETWORK	STRUCTURES IN *MANIBANDHA*	STRUCTURES IN *GULPHA*
LIGAMENTOUS NETWORK (*SNAYUJALA*) Including joint ligaments and retinaculum as accessory ligaments	Palmar radiocarpal	Deltoid
	Palmar ulnocarpal	Anterior talofibular
	Dorsal radiocarpal	Posterior talofibular
	Radial collateral	Calcaneofibular
	Ulnar collateral	Anterior tibiofibular
	Dorsal intercarpal	Inferior transverse tibiofibular
	Palmar intercarpal	Lateral talocalcanean
	Interosseous intercarpal	Medial talocalcanean
	Pisohamate	Interosseous talocalcanean
	Pisometacarpal	Cervical
	Extensor retinaculum	Talonavicular
	Flexor retinaculum	Plantar calcaneonavicular
	Dorsal, carpal and interosseous ligaments of distal carpal row	Dorsal cuneonavicular
		Bifurcate ligaments

	Dorsal, carpal and interosseous ligaments of mid carpal row	

TYPE OF NETWORK	STRUCTURES IN *MANIBANDHA*	STRUCTURES IN *GULPHA*
BONY NETWORK (*ASTHIJALA*) Including bones	Lower end of radius	Lower ends of tibia
	Ulna	Lower ends of fibula
	Scaphoid	Talus
	Lunate	Calcaneus
	Triquetral	Navicular
	Pisiform	Cuneiforms
	Trapezium	Cuboid
	Trapezoid	Proximal ends of metatarsal bones
	Capitate	
	Hamate	
	Proximal ends of metacarpal baones	

DISCUSSION

Jala verbally mean network. From previous description it is clear that Wrist and Ankle region is composed of numerous anatomical structures. Many muscles, tendons, arteries, veins, nerves, ligaments, retinaculum and bones are present at Wrist and Ankle which are not forming a true visible network like thing but presence of numerous structures which are compactly arranged, interwoven but well demacrated justifies the term network. Site of *Jala* that is *Manibandha* and *Gulpha* is itself a complex (*Sanghata*). There is no any description regarding function and importance of *Jala* for being at *Manibandha* and *Gulpha* is available. *Jala* are not present at any other place of body except Wrist and Ankle. Since every specialized function needs anatomical speciality and every anatomical speciality results into some different physiological outcome, *Manibandha* and *Gulpha* are special structures. All the synonyms of *Jala* indicate towards complexity. Complexity is the basis of all other features possessed by *Manibandha* and *Gulpha* which is possible due to *Jala*. Here *Mansa*, *Sira*, *Snayu* and *AsthiJala* provides complexity and in term strength and stability to *Manibandha* and *Gulpha* and makes higher degree of

controlled complex movements possible. *Jala* also makes *Manibandha* and *Gulpha* vulnerable to injury owing to its complexity.

Complexity

Wrist and Ankle region consist of many converging tendons and muscle bellies which are closely and compactly arranged. Wrist and Ankle region possesses many arteries, vein and nerve. Due to existence of numerous collateral circulation provided by anastomoses, ligation of main arteries is not followed by tissue necrosis or gangrene in distal segments. Large number of intercommunicating veins forms venous plexus. Wrist and Ankle are having rich nerve supply provided by division of many nerve trunks which works for coordinating and balancing complicated muscle activities and joints movements. *Manibandha* and *Gulpha* have numerous ligaments out of which many are not even properly named. Retinaculum which is also an accessory ligament binds all underlying structures. *Manibandha* and Gupha are comprises of many bones articulating through various joints. In case of Wrist there are radiocarpal, midcarpal and carpometacarpal joints. At Ankle there are talocrural, subtalar, intertarsal and tarsometatarsal joints. All these anatomical structures together make Wrist and Ankle region a complex structure.

Strength and Stability

Numerous strong converging tendons which are strongly attached to the bones, ligaments and articulations contribute for strength and stability against any dislocating forces during movements. Opposing action of extensor and flexor muscle tendon also creates balance and contributes to stabilize the Wrist and Ankle. *Sira Jala* through its immense Network make reach to every minute to minute structure providing nutrition and innervations thus maintaining strength and stability of Wrist and Ankle region and enable it to perform its functions. Wrist has a complex configuration of ligaments holding articulating bones in position and protects bones from abnormal movements. Retinaculum serves function of retaining structures in its place. Wrist and Ankle region possess large number of compactly arranged bones with intercommunicating surfaces. Shape of articulation and bone geometry influences the ability of the bone to resist mechanical loads maintaining a dynamic stability. Small carpal and tarsal bones are so arranged that it smoothly transfer weight and distributes

external force so that it acts as shock absorbers and provides stability and strength to Wrist and Ankle.

Higher Degree of Controlled Movements

Wrist is adapted for skilled movements with some extent of compromised stability and Ankle is adapted for strength with some extent of compromised movements. Special anatomy of Ankle and Wrist maintains delicate balances between strength and flexibility. Wrist act as modulator for length tension relationship in the tendons and facilitate effective positioning of the hand and powerful use of the extensors and flexors of the forearm. Insertion of flexor and extensor muscle systems into several major segments along the proximal-distal axis provides a variety of flexion-extension patterns in the digits. In spite of stability, Ankle is having enough range of motion to meet its requirements. Wrist and Ankle are having immense Network of artery, vein and nerve. Movement are actively controlled by the tendons through nerve pathways, ligaments control movements passively by virtue of their strength and flexibility. Large numbers of small carpal and tarsal bones have their anatomical importance as if there have been a single bone instead of group of bones, this degree of movements were not possible. Unique type of sliding movements and mobility of individual carpal and tarsal bones increase the freedom of movements. Carpal and tarsal bones provide a stable platform for metatarsal and phalangeal movements. Thus network of all the structures collectively contribute to the higher degree of controlled movements at Wrist and Ankle.

Vulnerability to Injury

Wrist and Ankle are constantly exposed to a wide variety of injuries due to its exposure to broad range of potential impacts from external forces as well as the damage sustained due to overuse injury through repeated motion. Vulnerability is due to Muscular, Neuroascular, Ligamentous and Bony Networks. Moreover due to thin skin, most of the articular, tendinous or vascular structures structures are superficially located. Wrist and Ankle are basically much stable for daily day to day activities but with the recent explosion of interest in sport and athletic activities, Wrist and Ankle have been exposed to a variety of new stresses. Ability of human to be engaged in sport activities is mostly dependent on foot and hand. It is challenge to perform variety of movements without compromising stability. Approximately Wrist or hand and Ankle

injuries constitute 3% and 25-30% of all sport injuries resp. Wrist and Ankle region have large number of muscle tendons. Tendon injuries take longer period for healing as tendons have a very low blood supply. Wrist and Ankle region are having complex Network of artery, vein and nerves. Since most of these are superficially located and compactly arranged, they are vulnerable to a variety of Neurovascular injury. Neurovascular injury may result in avascular compromise, permanent loss of sensation or nerve damage, tissue necrosis, thrombophlebities, gangrene, numbness, pain and also paralysis. Ligament injuries at Wrist and Ankle region are also common. When the forces directed into the joint exceed the strength of the joint, the ligament will become overstretched. Stretching of Wrist ligament are increasingly common injuries related to athletic throwing, baseball pitching, football passing, javelin throw, playing water polo and combat sports. Ligaments of Ankle are vulnerable to injuries especially during twisting, turning, and rolling of the foot like in tennis, basketball, volleyball and combat sports. Wrist and Ankle are having series of small bones connected by strong ligaments but since movements of Wrist and Ankle are comparatively more than knee, hip and elbow joints, chain of carpal and tarsal bones are more likely to get traumatized. Wrist and Ankle are engaged in most of sports activities and very little covering muscle or tissue on the top of the Wrist and Ankle, all significant external forces are absorbed by the underlying bone. This makes Wrist and Ankle more vulnerable to injuries. Being a connecting link between stable leg and forearm to mobile hand and foot, the Wrist and Ankle both are frequently vulnerable to injuries. Once injured its anatomical complexity prolongs the recovery period.

CONCLUSION

From the above discussion it is clear that a particular structure can't be compared to *Jala.* Group of structures can be said to forming network or *Jala* located at *Manibandha* and *Gulpha* playing important role in functions of Wrist and Ankle. *Jala* is a special structure and enables Wrist and Ankle to perform special functions. Since every special function needs anatomical speciality, does Wrist and Ankle have *Jala*. Individual *Jala* contributes to complexity of Wrist and Ankle making it stable while performing higher degree of controlled

movements. Complexity provided by *Jala* also makes Wrist and hand vulnerable to injuries.

Jala are anatomically important because of the fact that though Wrist is not one of the strongest structures of the body but the structure *Jala* balances the much needed skillfull movements with the desirable stability making human hand one of its own kind, unique possessing of homosepience. Ankle is homologus to the Wrist but somewhat different due to its adaptation for weight bearing during propulsive movements. Here *Jala* helps to makes uninterrupted propulsive movement at Ankle possible along with bearing huge weight of body which multiplies 3-4 folds while making quick movements. Different *Jala* enables Wrist and Ankle to perform their special functions for which they are adapted and act as a tool. Without *Jala,Manibandha* and *Gulpha* would not have been such an anatomically potent structure.

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