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Review Article

A COMPREHENSIVE REVIEW ON *HANUGATA AVEDHYA SIRA*

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ABSTRACT

Introduction: *Siravedhana*, is an important para surgical procedure to withdraw the vitiated blood from body but before performing it the knowledge of *Avedhya Sira* is mandatory as any injury to these can cause disability or even death. There is total 98 *Avedhya Sira* in the body. Out of which two are pertaining to the region of *Hanu*. Any injury to these can cause similar consequences. But the exact location and the structural entity pertaining to it is not clearly mentioned in the classic texts.

Material and Methods: Conceptual study carried out by reviewing classical texts, contemporary science, journals, published research works.

Conclusion: On the lateral aspect of the head near the anterior margin of the auricle in front of the tragus, the maxillary artery and Pterygoid venous plexus can be considered as *Hanugata Avedhya Sira* based on their location and *Viddha Lakshana*.

KEYWORDS: *Siravedhana, Avedhya Sira, Hanu Sandhi,* Maxillary artery, Pterygoid venous plexus.

INTRODUCTION

Ayurveda 'The Science of Life' is a holistic system of Indian Medicine, which represents the oldest complex medical system about healthy lifestyle principles. The main objective of Ayurveda is to protect health of the healthy person and to alleviate disorders in the diseased.[1] To achieve this objective of Ayurveda the knowledge of *Shareera* (body) has a great importance. For the better understanding of the subject, Ayurveda treaties had mentioned a separate *Sthana* i.e., *Shaareera Sthana,* it is the name given to that section which deals with all the *Daiva* and *Maanusha Sampat* related to the *Shareera* in detail.[2]

Sira is one of the important structural components of the body. The term *Sira* stands for channels through which *Rasadi Dhatu* flows from one place to another in the body and thus it helps to nourish the body and maintain healthy state.[3] *Sira* carries the *Rakta Dhatu* (blood) which helps to nourish the body and maintain healthy state. As the rivers and streams are maintaining the ecology of earth, similarly *Sira, Nadi*, and *Dhamani* are significant in maintaining life of living being. The important descriptions about *Sira* are mentioned by Ayurvedic mentors in Ayurvedic classical texts.

The *Sushruta Samhita* is one of the three great treatises of Ayurveda representing mainly the school of surgery. Anatomy being the basis of surgery, it is necessary to have proper knowledge of anatomical details before performing any surgery. Same in the case of *Siravedhana* (venesection), it is an important para surgical procedure performed to withdraw the vitiated blood from the body, before performing it the knowledge of *Avedhya Sira* is mandatory.

Acharya have explained gross location of the *Hanugata Avedhya Sira*, but an exact anatomical point has to be explored. Also, what exact structural entity pertaining to *Hanugata Avedhya Sira* has not mentioned. This region is frequently subjected to trauma, surgical interventions and diagnostic procedures. So, one should have a sound knowledge about the structures in the region and utmost care should be taken, as injury to these structures can leads to severe haemorrhage, disability and even death. Hence the knowledge to ascertain the exact location and to identify the anatomical structures pertaining to the *Hanugata Avedhya Sira* needs more clarification.

CONCEPTUAL REVIEW

Avedhya Sira

In a *Vedic* period, there was no description with respect to *Avedhya* or *Vedhya Sira*. Although it has mentioned that in vascular injury the outflow of the blood should be checked.[4]

In *Samhita* period, *Acharya Charaka* has described two *Vedhya Sira* in reference to with the disease *Unmada, Vishamajwara,* and *Apasmara* at two places i.e., *Shankha Pradesh* and *Keshanta Pradesh*,[5] but he did not mention specifically the *Avedhya Sira*.

The school of *Sushruta* discussed specific and detailed study of *Siravedha* as well as *Avedhya Sira* for the first time. *Acharya Sushruta* exerts few selected *Avedhya Sira*.[6]

Ashtanga Sangraha and *Astanga Hrudaya* also have mentioned *Vedhya Sira* but they have given them in connection with the disease.[7,8] No mention of specific *Sira* for a specific disease has been made.

The word meaning of *Avedhya* is unpierceable,[9] not to be pierced and word meaning of *Sira* is any tubular vessel of the body.[10] *Avedhya Sira* are those which should not be damaged during *Siravedhana* because their damage can cause disability or even death.[11] Even though *Siravyadha* is mentioned, it is also mentioned that the blood should be drawn in smaller quantities for curing various diseases since blood itself is the cause of the body and body is sustained by blood. Blood itself is life.[12] *Rakta* is one among the *Dasha Pranayatana* also. So, it should be saved from excessive loss.[13]

Classification and enumeration of the *Avedhya Sira*

Sushruta Samhita

Acharya Sushruta mentioned 98 *Avedhya Sira* which should be taken care by the surgeon at the time of *Siravyadha* or any other surgical procedures. Any trauma of these structures may lead to morbidity or death. They are as follows in table no. 1.[14]

Table 1: *Avedhya Sira* according to *Acharya Sushruta* [14]

S. No.	Location	Total No.	*Avedhya Sira*
1.	*Shakha*	400	16
2.	*Koshta*	136	32
3.	*Urdhvajatrugata*	164	50
	Total	**700**	**98**

Ashtanga Sangraha

Ashtanga Sangrahakara is also having the same opinion.[15]

Ashtanga Hrudaya

Acharya Vagbhata has slightly modified the knowledge of *Avedhya Sira*. His concept is that apart from these 98 *Avedhya Sira*, those *Sira* which are oblique, short, tortuous and narrowly placed in the subject should also be excluded while performing *Siravedha*.[16]

Hanugata Avedhya Sira

As per *Sushruta Samhita*, there is total eight *Sira* on each side of the region of *Hanu*. Among these, the two which are pertaining to *Hanu Sandhi* and known as '*Sandhi Dhamani*' should not be puncture.[17]

As per *Ashtanga Hrudyam* there are sixteen *Sira* pertaining to the region of *Hanu*. Out of these two, which performs *Sandhi Bandhana* i.e., helps in binding the joint are considered as *Avedhya Sira*. [18] *Ashtanga Sangraha* also has the similar opinion. [19]

Hanu Sandhi

Hanu Sandhi is situated on either side of *Hanu*. In classification of *Sandhi,* based on *Kriya* it is a *Cheshtavanta Sandhi* (movable) and based on *Rachana* it is a *Vayastunda Sandhi* (crow's beak like appearance). In *Cheshtavanta Sandhi* it comes under *Bahu Chala Sandhi*.[20]

MATERIALS AND METHODS

Conceptual study carried out by reviewing classical texts, contemporary science, journals, published research works.

DISCUSSION

Discussion on the location of *Hanu Sandhi*

The location of *Hanu Sandhi* in *Samhita* is mentioned as *'Hanvorubhayasta Vayastunda'* that means it is present on either side of *Hanu.* [21] As the word meaning of *Hanu* is mandible, so it is clear that it is present on either side of mandible. On this basis *Hanu Sandhi* can be correlated to temporo-mandibular joint (TMJ).

The TMJ is a combined hinge and planar joint formed by the condylar process of the mandible below and the anterior part of the mandibular fossa and articular tubercle of the temporal bone above. [22]

As per contemporary science the surface marking and location of particular structure is considered on the basis of the surface landmarks in the body that may be bony structure or muscular boundaries with respect to the skin surface. The landmark given for the head of the condylar process of mandible is, front of the tragus. It can be felt best during movements of the lower jaw. The tragus is a

small eminence anteroinferior to the external acoustic meatus. The external acoustic meatus lies near the anterior margin of the auricle. It is the opening to the ear. [23]

The site of TMJ articulation on the temporal bone is on the inferior surface of the zygomatic process. The specific location is situated on the posterior slope of the articular eminence. The articular eminence is defined as the strongly convex bony elevation on the root of the zygomatic process representing the anterior most boundary of the mandibular fossa also referred as the glenoid fossa. The articular tubercle is the bony "knob" on the lateral aspect of the articular eminence, where the fibrous capsule and the temporomandibular ligament attach. It would appear in the dried skull that, lying immediately anterior to the external auditory meatus. [24]

On the basis of above discussion, the location of the *Hanu Sandhi* can be considered on the lateral aspect of the head near the anterior margin of the auricle in front of the tragus on infratemporal fossa.

Discussion on *Viddha Lakshana*

As per classics any injury to *Avedhya Sira* can be proven as fatal as it causes *Vaikalyam* (disability) and *Maranam* (death). The consequences on injury to *Avedhya Sira* of *Hanu Sandhi* are not described separately, so they are considered as same as the general consequences on injury to *Avedhya Sira.*

The various vascular entities pertaining to the region of TMJ are superficial temporal vessels, facial vessels, retromandibular vein, maxillary artery and vein and pterygoid venous plexus.

Internal maxillary artery (IMA)

The internal maxillary artery remains a potentially more concerning issue as access can be difficult through traditional approaches to the TMJ potentially resulting in massive haemorrhage. It is the first portion of the internal maxillary artery that is at most risk for being injured during a temporo-mandibular joint procedure and maxillofacial fractures and causing massive haemorrhage which ultimately leads to death if not controlled on time or permanent disability due to nutrition of the body is carried out by arterial supply. If artery is damaged then the part supplied by it will not be nourished well and deformity may occur.

Shachika Khanna et al. did a literature and evidence-based research on life threatening haemorrhage in maxillofacial surgery by referring 40 articles. Study revealed that in orthognathic surgery, the maxillary artery was most frequently the source of massive haemorrhage. In this mortality rate was 20.21% and Patients requiring emergent airways were 79.81%.[25]

A retrospective study done by Tim Harrisa et al. revealed that in midfacial fractures the most commonly disrupted vessels include the branches of the external carotid artery, usually the maxillary artery which leads to life threatening haemorrhage and functional disability.

Percentage of life-threatening bleeding following facial trauma as per different authors was Sakamato et al. 24.4%, Cannell et al. 11.2%, Holmes et al. 20.0%, Shimoyama et al. 9.61%, Frable et al. 9.4%, Thaller and Beal 1.25%, Bynoe et al. 1.2%, Lucle et al. 0%.[26]

In a recent review of complications in a group of 655 patients undergoing orthognathic surgery, Panula et al. reported on 78 cases of severe intraoperative bleeding due to IMA tear during the medial cut of the sagittal split ramus osteotomy (SSRO). [27]

Sakamoto T et al. reported haemorrhagic shock due to rupture of IMA in 24% of severe blunt maxillofacial injury. [28]

Komiyama et al. reported six patients with bilateral IMA vessel injuries after trauma, five of which had received blood transfusions of more than 10,000 ml. Two of them died, two were in a vegetative state, one had moderate disability; only one patient had a good recovery. [29]

Since, the arterial pressure is more than venous pressure, there is risk of heavy and profuse bleeding in puncturing artery which may lead to deformity or death. In the case of IMA also on the basis of published data we have seen that injury to IMA leads to life threatening bleeding, haemorrhagic shock, death, functional deformity due to loss of blood supply.

The patients with ruptured IMA were presenting with compromised airways, disseminated intravascular coagulopathy, hypoxia, secondary brain injury, massive bleeding from ears, nose and oral cavity, deteriorated Glasgow comma scale (GCS), stuporous consciousness, dropped B.P., tinnitus, dilated or fixed pupils.

Deformities due to loss of blood supply includes restricted mandibular movement, muscle spasm, deviation of the mandible, malocclusion, osteonecrosis, facial asymmetry, growth disturbance and alteration of the balance in the masticatory muscles.

Pterygoid venous plexus (PVP)

Injury of venous plexus can be seen in trauma or persistent dislocation of the mandibular condyle, during surgical procedures or alveolar nerve block.

Lin Chang et al. retrospectively reviewed the cases of 27 patients who experienced intraoperative life-threatening bleeding during resection of a Juvenile nasopharyngeal angiofibroma (JNA) due to damage to the PVP. The amount of blood loss ranged from 200 to 5,000 ml (mean: 1,800) in the type III cases and from 700 to 8,000 ml (mean: 2,850) in the type IV cases. [30]

Guinto et al. described their use of the zygomatic trans-mandibular approach in the treatment of 10 patients with massive tumours that were localized in the infratemporal fossa. On drilling into the middle fossa, they noted profuse bleeding around the third vertebra, which was caused by the numerous veins in the pterygoid plexus. [31]

Nilton Alves et al. mentioned in their review article on cavernous sinus thrombosis of odontogenic origin that according to the different authors, dissemination of the infection can be seen via infratemporal in 21.43%, submandibular 7.14%. There was good recovery in 40% of the patients, 46.6% presented sequelae and 13.4% died. [32]

Infection is determined by trauma caused by a dental procedure that occurs when the pterygoid plexus is contaminated by a needle incorrectly inserted during the posterior superior alveolar nerve block. This accident can happen due to the communication between the cavernous sinus and the pterygoid plexus that is formed by a network of veins located in the infratemporal fossa.

When some specific vein with many tributaries is punctured, there is possibility of profuse bleeding which may leads to either deformity or death.

In case of PVP it is observed that injury results in life threatening bleeding, death, dissemination of the infection to cavernous sinus resulting in formation of thrombosis. Thrombosis blocks the normal drainage of the veins of the face causing periorbital oedema, among other clinical signs. Compression of contents of the cavernous sinus can lead to neuropathy of cranial nerves III, IV, V1, V2, and VI. Major symptoms include cranial nerve VI palsy, diplopia, ophthalmoplegia, and paraesthesia of the upper face covered by the ophthalmic and maxillary branches of the trigeminal nerve. Furthermore, cavernous venous thrombosis can potentially spread to the central nervous system. Since there are no valves in the cavernous system, the venous blood can spread to dural sinus and cerebral vein, potentially causing meningitis, brain abscess, or a stroke. [33]

The patients with ruptured PVP were presenting with massive blood loss, diplopia, ophthalmoplegia, exophthalmos, pulsatile tinnitus. Deformities include jaw displacement, limited mouth opening, impairment of excursive jaw movements, development of anterior open byte and temporomandibular ankylosis.

Superficial temporal vessels

Injury to Superficial temporal artery (STA) can leads to true or pseudoaneurysm that occur after few days to months of trauma to temporal region. Haemorrhagic conditions can also be seen. Most patients present within 2 to 6 weeks of injury, whereas 15% to 20% present 6 months to 3 years after initial injury. Common presenting symptoms include a solitary painless mass in the preauricular region accompanied by pulsations, headache, or ear discomfort. Less frequent complaints include pain, visual disturbance, dizziness, haemorrhage and cosmetic defect.

Matthew T. Walker et al. reported approximately 200 cases up to January 2003, based on published reports. [34]

As per Apoorva Vempati et al. the aneurysms of the STA account for <1% of the reported aneurysms. Most of these are pseudoaneurysms (PA) which develop after blunt or penetrating trauma to the temporal region. True aneurysms of the STA are very rare and usually of congenital, atherosclerotic or hemodynamic origin. Approximately 400 patients with STA aneurysm were reported in literature up to April 2020, the majority of the cases are posttraumatic pseudoaneurysms. Out of that true aneurysms are seen only in 10% of all STA aneurysms. Till date, only 34 cases of true aneurysms of STA have been reported in literature. [35]

Goldwyn reported 5 cases of late bleeding after rhytidectomy resulting from injury to the superficial temporal vessels. [36]

Owsley described a case of life-threatening haemorrhage from a dehisced scalp incision after a face lift procedure, which was managed with transfusions and emergency ligation of the injured branch of the superficial temporal artery. [37]

Blunt trauma to the STA may cause both aneurysm and Arteriovenous fistula (AVF), but the incidence of AVF is lower than that of aneurysm, with a ratio of 23:131, and only 36 cases have been reported as of 2007. [38]

Reports of AVF are surprisingly scarce. An extensive literature review uncovered only 34 examples, which were virtually exclusively presented as individual case reports or very small case series. [39]

As per Otacilio de Camargo et al. AVF of the superficial temporal artery is a rare condition, with an estimated incidence of 0.5% to 2.0% of cases. [40]

Jatin Bodwal et al. reported a rare case of fatal bleeding from a laceration of superficial temporal artery. The peculiarity of that case lied in the fact that no evidence of fatal accidental superficial temporal artery had ever been reported in the forensic literature. Injury to STA can also leads to hemorrhage but it is seen very rarely. [41]

Retromandibular vein (RMV)

Hemorrhage due to rupture of RMV can occur during parotidectomy but it is very uncommon. There is no significant number of case reports regarding this.

Facial vessels

Aneurysm or pseudoaneurysm of facial vessels can occur secondary to trauma. But these are rare conditions.

John A. Germiller et al. reported a case of oropharyngeal haemorrhage due to trauma to proximal facial artery, one month secondary to gunshot wound to the neck. As per author, this was only the second report of PA involving the proximal facial artery, and the first was of a facial PA rupture into the pharynx. [42]

Otasowie D. et al. did a retrospective study on life-threatening haemorrhage secondary to maxillofacial injuries on 14 cases in a Nigerian tertiary care centre. The source of intraoral bleeding was from fractured mandible. The facial artery or its tributaries were the most common bleeders encountered in 7 patients. Mortality was recorded only in 1 patient. [43]

So, as per above mentioned studies we can observe that there is higher rate of disability and mortality on injury of IMA and PVP as compared to other vasculatures.

Discussion on the structural entity

In *Samhita* detailed description regarding what exact structural entity, we have to consider in relation to *Avedhya Sira* of *Hanu Sandhi* is not mentioned. Only the phrase '*Sandhi Bandhana Karmani*', '*Sandhi Dhamani'* and *'Sandhi Sambandhaniyo'* is used.

The meaning of '*Sandhi Bandhana Karmani*' is that the structure which takes part in binding or formation of the joint.

As per *Sushruta Samhita,* apart from *Asthi Sandhi, Sandhi* is also present in between*, Peshi, Snayu* and *Sira.* So, there are four structural entities which participates in *Sandhi Bandhana Karma.*

Here, out of these four structural entities that is *Asthi Sandhi, Peshi Sandhi, Snayu Sandhi* and *Sira Sandhi* we need to specify only one structural entity as *Avedhya Sira* of *Hanu Sandhi* based on their *Viddha Lakshana*.

Acharya has described specific signs and symptoms if any injury occurs to *Sira, Snayu, Asthi* and *Mamsa*.

If *Sira* are cut, copious blood of colour like *Indragopa* (red) flows out of the wound and *Vayu* causes various disorders.

As per *Bhavamishra*, injury to *Sira* leads to *Sandram Ajasram* (continuous flow of the thick blood), *Bahu Asruk Sravet* (excess blood flow) due to this *Trishna* (thirst), *Bhrama* (giddiness), *Shwasa* (dyspnoea), *Moha* (delusion), *Hiddhma* (hiccup) arise ultimately leading to *Antaka* (death).

If *Snayu* is punctured hump back, lassitude, loss of energy in actions, severe pain and delayed healing of wounds, these symptoms appear.

Continuous severe pain in every position, having no relief, thirst, lassitude, swelling with pain, these symptoms indicate punctured *Asthi*.

One injured at *Mamsa Marma* does not perceive touch sensation and is of pale complexion.

On the basis of *Viddha Lakshana* of *Avedhya Sira* that is *Vaikalyam* (disability) and *Maranam* (death); these symptoms coincide with the *Viddha Lakshana* of *Sira,* injury to which also ultimately leads to death due to excessive blood loss and also as the function of *Sira* is providing nutrition *(Poshaka Karma)* to the whole body if *Sira* will cut off, due to lack of nutrition that part will get emaciate and disable.

So, from above discussion we can consider the meaning of phrase '*Sandhi Bandhana Karmani*' as *Sira Sandhi* as a structural entity for *Avedhya Sira* of *Hanu Sandhi.*

As per modern science there are various anastomoses, venae comitantes, arterial, venous or nerve plexus which are formed by the union of various arteries, veins and nerves.

The meaning of *Sira Sandhi* is the union or binding between two or more *Sira.* In the modern counterpart we can consider various anastomoses, plexus, venae comitantes pertaining to the region of *Hanu Sandhi* as *Sira Sandhi.*

On the basis of *Viddha Lakshana* the mortality and disability rate are higher on the injury of IMA and PVP. Also, both these structures participate in the formation of Kiesselbach's plexus and pterygoid plexus respectively which can be consider as *Sira Sandhi*.

In *Sushruta Samhita,* the word *Sandhi Dhamani* is used for the *Avedhya Sira* of *Hanu Sandhi.* But *Acharya Dalhana* in his commentary clearly mentioned that the *Sira* which takes part in *Sandhi Bandhana Karma* that is helps in binding the joint is considered as *Avedhya Sira* of *Hanu Sandhi.* He used

the word *Sira* itself. So, we can consider it as *Sira* only.

In *Ashtanga Sangraha* the word *Sandhi Sambandhaneyo* has been used for the *Hanugata Avedhya Sira,* which means the *Sira* which is related or pertaining to the region of *Hanu Sandhi* should be consider as *Hanugata Avedhya Sira.*

Internal maxillary artery and pterygoid venous plexus are the major vessels providing nutrition to the TMJ and infratemporal fossa and responsible for sustenance of life.

Discussion on the location of *Hanugata Avedhya Sira*

As per discussion on structural entity and *Viddha Lakshana* it is clear that among various vascular entities pertaining to the region of TMJ, the disability and mortality rate is higher in the internal maxillary artery and pterygoid venous plexus if any trauma occurs.

Maxillary artery begins behind the neck of mandible, its first part is present in between the neck of the mandible and the sphenomandibular ligament. The second part; runs upwards and forwards superficial to the lower head of the lateral pterygoid and third part is present between the two heads of lateral pterygoid muscle. The mean distance between the artery and the medial border of the mandible in the sub-condylar region is 6.8 mm with a range of 4.06–8.47 mm. The distance between the internal maxillary artery and the mandible ranges between 2.94 and 4.97 mm at the most inferior portion of the sigmoid notch. It also takes part in formation of Kiesselbach's plexus which can be considered as *Sira Sandhi.*

If we observe the course of pterygoid plexus of veins, it is lying between the medial and lateral pterygoid muscles, and between the lateral pterygoid and temporalis muscles. It is also formed by the congregation of multiple veins.

CONCLUSION

On the basis of conceptual study, location of the *Hanugata Avedhya Sira* can be considered on the lateral aspect of the head near the anterior margin of the auricle in front of the tragus on infratemporal fossa. Any trauma to *Avedhya Sira* due to mechanical injury or while performing *Siravedhana* can cause disability or death. In the Infratemporal fossa it can be occur due to trauma of Maxillary artery and pterygoid plexus of veins. The damage of these structures causes individually higher rate of disability and death as compared to other structures present in the region of TMJ. So, these vessels should be protected by wearing helmets and other protective shields to avoid traumatic injury and also during surgical practice without altering the normal physiology.

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