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Anatomical and Pathophysiological Considerations of Marma with Special Reference to Shock

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Abstract

Shock is described as a condition in which progressive failure of the body functions is observed; resulting from surgical operations, trauma, wounds, intoxication or infections. Most of the time this condition is more or less rapidly leads towards death. It is a patho-physiological state in which there is a significant systemic reduction in tissue perfusion resulting in decreased tissue oxygen delivery. Which in due course leads to an irreversible cell and tissue death and ultimately results in end-organ damage, multi-organ failure and death.

Causes of shock may vary from hypovolemia to spinal cord injury. Whatsoever the cause it ultimately end up in the circulatory failure causing death.

Since ancient time *Aacharya Sushruta*; popularly known as the father of surgery was very well aware of in human being. (*Aacharya Sushruta*: the father of surgery has written in depth about different factors responsible for death.) He has not only described importance of blood but also mentioned the measures to arrest bleeding. It shows that he was very well aware about the fact that severe haemorrhage may lead to death by hypovolemia. Also while describing complications of traumatic wounds *Aacharya Sushruta* has mentioned the signs and symptoms of shock. This ultimately proves his expertise in clinical knowledge.

As *Sushruta* has dedicated most of his compendium to surgical part of treatment, he has mentioned certain vital spots in the body which must be protected while performing any surgical or para surgical procedure. Moreover, he has also written a full text on vital spots which must be protected from any kind of injury. Such spots are termed as *Marma*. All vital spots do not always cause death when injured. Some may cause deformity or severe pain. When we consider death by shock we must emphasize only on the *Marma* or fatal spots which cause death when gets injured.

This article is written to elaborate the anatomical and physiological aspects of shock especially due to injury to certain fatal spots causing death.

Keywords- *Marma*, Hypovolemic Shock, Head Injury, *RaktaKshaya, Sadyapranhara Marma*

Introduction

Shock

Shock is one of the major medical emergency having a high mortality rate. It is a condition in which the cardiovascular system fails to perfuse tissue adequately. It is imbalance between supply and demand of body. There may be either increased demand or decreased supply of oxygen in tissues or both. The mortality rate of cardiogenic shock is 60-70%, septic shock is 35 to 40% and in hypovolemic shock varies according to a disease state. [1]

Types of shock-

There are four major types of shock viz. hypovolemic shock, cardiogenic shock, distributive shock and obstructive shock. When we consider the shock due to trauma it mostly comes under the hypovolemic shock and neurogenic shock which is a subtype of distributive shock. Hypovolemic shock results due to blood loss and neurogenic shock is consequence of destruction of spinal cord integrity. [2]

Pathophysiology of hypovolemic shock [3]

Hypovolemic shock is the result of either blood loss or loss of extracellular fluid. Traumatic injury is the most common cause of blood loss causing hypovolemic shock. Haemorrhage due to traumatic injury results in depletion of intravascular volume. Our body tries to compensate this phenomenon with peripheral vasoconstriction, increase in cardiac contractility and increased in heart rate. Clinically it is presented by increased diastolic blood pressure with slow pulse rate. If volume continues to decrease systolic blood pressure decreases. As a result of this oxygen delivery to vital organs decreases. Due to less supply of oxygen, cells switch from aerobic to anaerobic metabolism which results lactic acidosis.

As sympathetic drive increases, blood flow is diverted to vital organs like heart and brain. This further increases the tissue ischemia and ultimately increases the lactic acidosis. If this condition is not corrected, there will be increased hemodynamic compromise and eventually death.

Pathophysiology of neurogenic shock [4]

Neurogenic shock is the most common consequence of traumatic spinal cord injury primary or secondary. 19.3 % cervical spine injuries and 7% of thoracic injuries presents with neurogenic shock. Sometimes spinal anaesthesia may also induce neurogenic shock.

Associated fracture or dislocation of vertebra in the cervical or upper thoracic spine causes the disruption of descending sympathetic tracks.

Response to primary spinal cord injury manifests within few minutes of injury. Primary injury is direct damage to the axons and neural membranes in the intermedio-lateral nucleus, lateral grey matter and anterior root that lead to disrupted sympathetic tone.

Response of secondary spinal cord injury occurs hours to days after initial traumatic insult. This vascular trauma causes electrolyte shift resulting in oedema which leads to progressive central haemorrhagic necrosis of the grey matter at injury site. A hemodynamic change occurs after injury to the spinal cord above the level of T6.

Neurogenic shock is a combination of both primary and secondary injury which results in loss of sympathetic tone and unopposed parasympathetic response driven by the Vagus nerve. It may resolve spontaneously or may cause

cardiac arrest leading to death. It presents with bradycardia, hypotension, arrhythmia, hypothermia, fainting and dizziness. It is mainly a vasodilatory shock.

According to *Aacharya Sushruta* there are certain anatomical sites in the body which are seats of life. These are called as **Marma** or fatal spots, where especially life resides. Hence whenever fatal spots are injured, they produce their respective effects. In general all kind of injuries to fatal spots either produce deformity or death. [5]

Review of literature

The term *Marma* is defined as *Maryanti iti Marma*; means those sites, when injured become life threatening for that person. [6] There are certain anatomical sites in our body where especially life resides. Hence if they get injured the life of the person gets endangered. This is the reason why they are called as fatal spots or vital spots. *Marmas* are confluence of certain anatomical structures like muscles, veins, ligaments, bones and joints. [7]

Knowledge of the fatal spots is described as half of the knowledge of *Shalya Tantra* (Science of surgery), because during surgical procedures if these fatal spots are injured then the person may die. Even if such person survives by the competency of the physician he will suffer from deformity. [8] Hence a surgeon must have thorough knowledge about the fatal spots and he should protect these spots from injury while performing any surgical or para-surgical procedure.

Further while mentioning the importance of protecting fatal spots from injury *Sushruta* narrated that-at one time even the patients whose internal organs are punctured, skull fractured, body parts are cut off by sharp weapons; legs, shoulders, feet and hands are amputated may survive if the fatal spots are not injured during these assaults. But if the fatal spots are injured then survival of such patients becomes challenging. [9]

In total there are one hundred and seven *Marmas* (fatal spots) in the body. They are divided according to different aspects viz. on the basis of effect when they gets injured; on the basis of tissue predominance in that area and on the basis of anatomical disposition i.e., surface anatomy of that spot. [10]

There are five types of Marma on the basis of effect when gets injured as follows [11] –

1. ***Sadya Pranhara Marma-*** i.e., causing death from zero to seventh day of injury. These are nineteen in number.
2. ***Kalantar Pranahara Marma-*** i.e., causing death between seven to fifteen days of injury. These are thirty three in number.
3. ***Vishalyaghna Marma-*** i.e., causing death after removal of foreign body. These are three in number.
4. ***Vaikalyakar Marma-*** i.e., causing deformity after injury. These are forty four in number.
5. ***Rujakar Marma-*** i.e., causing severe pain after injury. These are eight in number.

Sadya Pranahar Marma are *Agneya*. *Agneya* refers to tendency of quick and severe exhibition of symptoms after trauma (*Marmaghata*). Injury at these spots kills debilitated persons just like fire spreads quickly.

Kalantara Pranahara Marma are *Saumyagneya* in nature i.e., having qualities of water and fire mixed together; hence injury at these spots may kill the victim quickly in some cases due to fire quality and in others death may occur after sometime due to quality of water.

Vishalyaghna Marmas are *Vayavya* in nature i.e., having qualities of air. As long as air remains trapped inside the body by the presence of foreign body i.e., *Shalya*, the person sustains life. But as soon as the foreign body is pulled out of the body; air residing in the fatal spot sets free which ultimately resulting in death. Patient may survive if the foreign body comes out on its own as a result of suppuration at the fatal spot. Considering rapid deterioration (Gati) of condition after removal of *Shalya*, *Vayu* is supposed to be a key factor in *Vishalyaghna Marmas*.

Vaikalyakar Marmas are *Saumya* (i.e., possessing qualities of moon or water). *Somya* refers to quite a mild quality. One that is gentle rather than aggressive and, thus, has a softer and mild effects. Despite of the deformity due to injury at these spots patient sustains the life owing to the stability and cold nature of water.

Rujakara Marma are predominantly having properties of fire and air. Both these are known to cause pain. *Agni* and *Vayu* at these *Marmas* are considerably mild, hence no obvious serious manifestations are seen after *Maramaghata*. [12]

Sadya Pranahara Marma when injured, kills the person within seven days; *Kalantara Pranahara Marma* kills within a fortnight or a month. Even if the *Kshipra Marma* comes under the subtype *Kalantar Pranahara Marma*, it may kill the person swiftly if get injured. [13]

Even *Vishalyaghna Marma* and *Vaikalyakar Marma* may cause death if they are critically injured.

Anatomical Consideration of *Marma* -

Though it is not clearly mentioned which anatomical structure is involved at the sites but we can predict from the effect what must be the structure involved. Like in case of *Indra Basti Marma* which is present at forearm and calf region respectively, death is said to be due to haemorrhage. Hence we can predict that radial artery and tributaries of cephalic vein in forearm and posterior tibial artery and vein in calf region must be injured to cause the blood loss and hypovolemic shock resulting in death. [14]

Similarly in *Lohitaksha Marma* axillary artery and vein; in *Stanarohita Rohita Marma* pulmonary and internal mammary artery and vein and ascending aorta, superior vena cava may get injured. [15] In *Katikataruna* anatomical structure involved may be superior gluteal artery and vein. [16] In *ParshvaSandhi Marma* common iliac artery may be injured. *Bruhati Marma* may comprise of subscapular artery and vein. [17]

Stanamula and *Apastambha Marma* are present on chest and injury to these *Marma* causes death after sometime due to respiratory arrest. Though they are mentioned as *Sira Marma* depending upon the predominance of anatomical structures, we can conclude that these maybe lung and its appendages as they are causing death by respiratory arrest when injured.

Matruka Marma is said to be *Sira Marma* causing the effects *SadyoPranahara*. These can be considered as common carotid artery and internal jugular vein respectively. [18]

When we consider *Hrudaya Marma*, it clearly indicates the structure heart, ascending aorta, superior and inferior vena cava and pulmonary veins; which might get injured causing quick death. [19]

Also in case of *Nabhi Marma*, though anatomy is not clearly mentioned; according to the anatomical site we can say that it must be the abdominal aorta. [20] *Basti Marma* can be clearly taken as urinary bladder. If it is injured at two different sites, it causes sudden death. When we explore about the bladder injury there are two types of rupture of bladder one is intra-peritoneal and other is extra-peritoneal. Intraperitoneal rupture of bladder will cause the extravasation of urine causing peritonitis, uraemia and death. While extra-peritoneal rupture will cause injury to hypogastric plexus causing hypovolemic shock. [21] *Nitamba Marma* is situated at illium and sacrum bone. Structures involved at this site are sacroiliac joint, anterior and posterior sacroiliac ligaments, sacral plexus, psoas major and iliac muscle. Injury to iliac bone and sacral plexus will cause functional loss, wasting of the muscles and death. [22] When we consider the fatal spots situated at the head; we can conclude it as head injuries causing brain insult enough to result in death.

Shankha Marma is situated at temporal region. The structures present at this spot are temporal artery as well as anterior and posterior branches of middle meningeal artery. Injury to these arteries is the most common cause of epidural haematoma causing death. [23] *Utkshepa Marma* is situated at zygomatic temporal area. Structures like zygomatic artery, temporal artery, internal carotid artery and anterior temporal diploic vein may get injured due to trauma at this site [24]

Sthapani Marma is situated at frontal bone and trauma to this site may injure supra orbital and facial artery [25]

Simant Marma can be considered as coronal, sagittal and lambdoid sutures in the skull. Anterior and posterior superficial temporal and occipital arteries, occipital diploic vein, posterior, anterior and frontal parietal veins are present at this site. [26]

Shrungataka Marma is the seat of supra orbital artery, frontal diploic vein and superior sagittal sinus. [27]

Adhipati Marma is situated at posterior frontalle involving confluence of sinuses which is the connecting point of superior sagittal and occipital sinuses. [28]

Pathophysiological aspects-

Sushruta has not only mentioned the predominant anatomical structures present at the site of *Marma* but also mentioned the pathophysiology of death due to injury at these sites. He mentioned that, when *Kshipra Marma* gets injured there will be death due to convulsions. These convulsions may be due to sudden blood loss. [29] In case of *Talahrudaya Marma* injury, death will be due to severe pain.[30] When *Indra Basti Marma* is injured there will be huge loss of blood resulting in death [31]; similarly in case of *Lohitaksha Marma*, death will be due to haemorrhage. [32] *Guda Marma* when injured causes sudden death which may be due to peritonitis. [33] When *Basti Marma* is injured at two different sites at the same time, it causes sudden death which may be due to peritonitis or suppurative pelvic cellulitis leading to septic shock [34] Heart is the site of *Sattva, Raja, Tamas Guna* as well as *Para Ojas*. Hence injury at this site causes immediate death. [35] *Stanamula Marma* when injured causes emphysema and it leads to death due to respiratory arrest. [36] Similarly *Stana Rohita Marma* injury causes haemothorax and respiratory arrest which ultimately leads to death. [37] Injury to *Apastambha Marma* also causes respiratory arrest and death due to pneumothorax. [38] *Apalapa Marma* when injured causes suppuration of blood and ultimately death. [39] Injury to *Katikataruna Marma* causes death due to loss of blood producing whitish discolouration of skin and loss of complexion. [40] Trauma at *Nitamba Marma* causes death due to wasting of lower body and general debility. [41] Injury to *ParshvaSandhi* causes death due to intra-abdominal haemorrhage. [42] Injury to In case of injury at *Bruhati Marma* death is seen as a complication secondary to profound haemorrhage. [43] In case of *Utkshepa Marma* if the object of trauma is impacted at the site, it should not be removed. If impelled object is pulled out then patient will not survive. [44] Similarly, in case of *Sthapani Marma* impelled object should not be removed to avoid death. [45] Injury to *Simanta Marma* leads to insanity, fear, loss of intellect or unconsciousness and ultimately death. [46]

Discussion-

Shalyatantra, the branch of *Ayurveda* has the most advanced knowledge of basic principles of surgery. *Sushruta* the writer of compendium *Sushruta Samhita* was an expert surgeon who was having the profound knowledge about the fatal spots which should be protected during any surgical or para-surgical procedure. He has given utmost importance to the knowledge of *Marma* i.e., fatal spots while performing any major or minor surgical procedure. He was well aware about the mortality associated with the injury to these fatal spots. He has also mentioned the structural anatomy of these fatal spots and probable pathophysiology responsible for death following injury.

If we go through the description of *Marma* we can conclude that *Sushruta* has stated almost every cause and pathogenesis of traumatic shock responsible for death. While describing the causes of death due to injury at fatal spots he has described various types like hypovolemic shock, neurogenic shock and even septicemic shock.

While considering hypovolemic shock he has mentioned certain *Marmas* in which death occurs due to loss of blood. For example *Kshipra, Indrabasti, Lohitaksha, Stanarohita, ParshvaSandhi, Bruhati.* The death may be sudden or after some time depending upon the anatomical structures injured.

Injury to *Talhruday Marma* causes death due to pain. This can be taken as neurogenic shock. Injury to *Basti Marma* leads to suppurative pelvic cellulitis causing death due to septic shock. Also in case of *Apalap Marma* the death is due to sepsis.

When we consider the fatal spots situated at the head; we can say that all these are head injuries causing brain insult enough to result in death. Trauma on *Shankha Marama* (which is present between ear and forehead) causes sudden death as temporal bone is thin and consists of blood vessels of importance (meningeal vessels). *Adhipati Marma* and *Avarta Marma* are described as *Sira* and *Sandhi Sannipat*. *Shrungataka Marma* which is assumed to be a confluence of sinuses in the skull is also area of utmost sensitivity as it is open sinus with meningeal venous blood. Hence trauma at these sites may become life threatening.

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When *Simanta Marma* gets injured the signs and symptoms produced are similar to those of the focal brain injury, ex. altered consciousness, mood and personality changes, unconsciousness, coma and death.

Hence we can conclude that injury to *Marma* causing death is similar to the shock mentioned in modern era.

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