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ORIGINAL RESEARCH PAPER

The Heart-Axon Axis: Correlating *Vyana Vayu* with Bioelectrical Signaling in Neurocardiac Pathways

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ABSTRACT

Background: *Vyana Vayu* is the all-pervading sub-dosha of *Vata Dosha*, which arises in *Hridaya* (heart) and traditionally regulates bodily movement, circulation and integration of sensory-motor function. The characteristics of *Vyana Vayu* include an all-encompassing nature of spread with *Mahajava* (great velocity), *Prasarpana-Akunchana* (contractility and extensibility) and systemic regulatory capacity. There are two possible biomedical correspondences related to *Vyana Vayu*: (i) Biophysics of action potential (AP) and nerve conduction and (ii) Cardiac neuro-humoral control mechanisms.

Aims and Objectives: (1) Correlation between *Vyana Vayu* attributes and biophysics of the AP/nerve conduction; (2) Association of *Vyana Vayu* properties with cardiac neuro-humoral signaling; (3) Proposal of the concept of "Heart-Axon Axis" as a translational framework; (4) Contemporary biomedical understanding of *Vyana Dushti* and *Ayurvedic* management approaches to it.

Materials and Methods: Classical *Ayurvedic* literature such as *Charaka Samhita, Sushruta Samhita* and *Ashtanga Hridayam* was analyzed, together with an electronic literature search from PubMed, Scopus and AYUSH resources (2000–2025). Diagnostic criteria of *Vyana Dushti* were correlated with nerve conduction velocity and electromyography.

Observations and Results: *Vyana Vayu* has a correlation with two biomedically related entities: (i) AP and nerve conduction physiology: Ion gradients (Na^+/K^+), membrane depolarization, saltatory conduction and neuromuscular excitation-contraction coupling (ii) Cardiac neuro-humoral signals: Intrinsic Cardiac Nervous System, cardiokines (atrial natriuretic peptide, brain natriuretic peptide and calcitonin gene-related peptide); exosomal micro RNA signaling and vagal-sympathetic balance. *Vyana Dushti* corresponds clinically with peripheral neuropathy, cardiac arrhythmias and autonomic dysfunction.

Conclusion: The concept of the "Heart-Axon Axis" integrates *Vyana Vayu's* bioelectric and neurohumoral components into a unified translational framework that may be beneficial in integrating cardiovascular-neurology research and evidence-based.

1. INTRODUCTION

Vyana Vayu, which is the most widespread among the sub-types of *Vata Dosha* in *Charaka Samhita* (*Chikitsa Sthana 28/15*) *and Ashtanga Hridaya* (*Sutrasthana 12/5*), originates in the *Hridaya* (heart) and disseminates throughout the body at *Mahajava* (very high speed), controlling all types of bodily movements such as circulation, sensory-motor coordination and movement. Two parallel paradigms have been proposed in contemporary biomedicine that can facilitate a more detailed analysis of classical features of *Vyana Vayu*. Neurophysiology describes the action potential (AP), defined as a fast, self-propelled electrochemical signal a s a fundamental component of

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neurotransmission, whose ion dynamics and conduction properties share many characteristics with the *Mahajava* and *Prasarpana* (propagation) of *Vyana Vayu*.[1-6] Secondly, neurocardiology has redefined the heart as a neurosecretory organ, featuring intrinsic innervations, bidirectional vagal-brain interaction and the production of cardiokines.[7,8] These features resemble heart-originating and omnipresent qualities of *Vyana Vayu*.

Bioelectrical analogy or neurocardiac analogy has been studied independently by previous research.[9,10] The current study attempts, for the 1st time, to suggest a combined approach in the form of "Heart-Axon Axis" involving nerve conduction velocity (NCV), heart rate variability (HRV) and electromyography (EMG) biomarkers.

1.1. Aims and Objectives

1. To correlate between *Vyana Vayu* attributes and biophysics of the AP/nerve conduction
2. To associate *Vyana Vayu* properties with cardiac neuro-humoral signaling
3. To propose the concept of "Heart-Axon Axis" as a translational framework
4. To understand the concept of *Vyana Dushti* and *Ayurvedic* management approaches to it.

2. MATERIALS AND METHODS

Classical *Ayurvedic* literature, *Charaka Samhita*, *Sushruta Samhita* and *Ashtanga Hridaya,* was analyzed for descriptions of *Vyana Vayu*'s origin, spread and pathological manifestations (*Vyana Dushti*). This was supplemented with an electronic literature search of PubMed, Scopus and AYUSH-affiliated resources (2000–2025), using keywords including *Vyana Vayu*, AP, NCV, intrinsic cardiac nervous system (ICNS), cardiokines and HRV. Descriptors extracted from the classical texts were cross-correlated against two biomedical domains: (1) The biophysics of the AP/peripheral nerve conduction and cardiac neuro-humoral signalling, and (2) Diagnostic correlates of *Vyana Dushti* were mapped against NCV, EMG and HRV to construct the integrative frameworks.

3. OBSERVATIONS AND RESULTS

Correlating the classical descriptions of *Vyana Vayu* against the biomedical literature yielded consistent correspondences across two domains, that is, (1) the bioelectrical (AP and peripheral nerve conduction) and (2) the neurohumoral (cardiac endocrine and autonomic signaling).

3.1. The Basic Classical Features Associated with *Vyana Vayu*

i. *Hridaya* as the locus of origin
ii. *Sarvadeha-Chara* – diffusion simultaneously in all parts of the body
iii. *Mahajava* - rapidity of dissemination
iv. Control over *Rakta Vaha Srotas* (circulation)
v. *Indriya Karma* – coordination of sensory and motor activities
vi. *Prasarana-Akunchana* – spreading and contraction
vii. *Sveda Pravritti* – stimulation of secretion.[11-14]
viii. *Vyana Dushti* (pathological state of *Vyana Vayu*) presents itself as a group of signs like *Suptata* (numbness), *Stambha* (stiffness), *Kampa* (tremors), *Vaikruta Gatih* (abnormal movements) and *Hridroga* (heart rhythm disturbances), which perfectly overlap with dysautonomia/peripheral neuropathy syndrome.

Key Sanskrit operational terms – *Mahajava* (speed), *Prasarpana* (propagation), *Akshepan* (excitation-contraction), *Gati Sangha* (conduction obstruction) function as precise physiological descriptors whose biomedical equivalents are only now being formally recognised.

3.2. Biophysics of the AP: Bioelectric Mechanism of *Vyana Vayu*

3.2.1. Ionic imbalance and propagation

A resting membrane potential (−70 mV in neurons; −90 mV in cardiac cells) is generated by a difference in Na^+/K^+ concentrations across the cell membrane. The depolarization from stimulus-induced Na^+ influx occurs to +35 mV (*Mahajava*), which gets repolarized back due to K^+ outflow to the initial value (one *Prasarpana* - repolarization process), resulting in hyperpolarization (refractoriness period). It ensures the directional propagation of the AP and its rhythmic nature. In cardiomyocytes, an unusual plateau is observed due to calcium channels, which are responsible for the systole of the heart governed by *Prasarana-Akunchana* of *Vyana Vayu* in *Hridaya.*

3.2.2. Myelinated conductivity or saltatory propagation and Mahajava

APs travel through saltatory conduction along myelinated axons, jumping from one Node of Ranvier to another in a speed of 70–120 m/s that directly translates to *Mahajava.* Myelin represents the function of *Majja Dhatu* in maintaining the pathways of *Vyana Vayu* in nerves. Loss of myelin due to any reason, including autoimmunity, metabolism (*Dhatu Kshaya*), or inflammation (*Avarana*), leads to an immediate drop in NCV as a quantifiable measure of the severity of *Vyana Vayu* dysfunction. In the neuromuscular junction, acetylcholine-induced fibre muscle depolarization and actin-myosin coupling operationalize *Akshepan* (excitation into contraction), closing the circuit from neural *Vyana Vayu* to its muscular expression (Figure 1).

3.3. Heart as a Neurohumoral Organ

3.3.1. ICNS

ICNS is made up of approximately 40,000 neurons consisting of sensory, afferent, efferent and interneurons residing in the cardiac ganglionic plexus as a "little brain" capable of intrinsic cardiac reflex regulation independently of the central nervous system (CNS). This directly implements *Charaka Samhita*'*s* description of the *Hridaya* as the *Mula* (root intelligence center) of *Vyana Vayu*. Significantly, the approximate 80–90% of vagal fibers are afferent, transporting cardiac status information to the nucleus tractus solitaries, hypothalamus, and insular cortex.[15] Such afferent preponderance reflects *Vyana Vayu*'*s Urdhva Gati* (upward propagation), that is, the heart constantly keeping the mind (*Manovaha Srotas*) informed about the body state through visceral-cortical *Indriya Karma.*

3.3.2. Cardiokines and regulation of rasa dhatu

The endocrine function of the heart operationalizes molecular pathways involved in the systemic distribution of *Rasa Dhatu* by *Vyana Vayu*. Atrial natriuretic peptide (ANP) and B-type natriuretic peptide (BNP) maintain blood pressure, sodium concentration, and vascular tone.[16,17] Calcitonin gene-related peptide (CGRP) secreted alongside cardiac sympathetic neurons controls vascular dilation and sensory signaling.[18] FGF21 is involved in linking cardiac and systemic metabolism control. Exosome nanovesicles containing microRNA-21 (miRNA-21) and miRNA-126 from cardiac tissue constitute *Sukshma Srotas* (Subtle channels).[19]

3.4. Integrative Correlation

Described in Table 1.

3.5. Clinical Correlation: *Vyana Dushti*

Described in Table 2.

3.5.1. Neurological signs

The neurological sign *Vyana Dushti* due to *Avarana* (blockage of conduction) is demyelinating peripheral neuropathy that is characterized by a delayed distal motor latency and slowing of NCV.[20,21] The degree of NCV slowing is an index of the severity of dysfunction of the conductive pathways of *Vyana Vayu*.

3.5.2. Cardiovascular signs

Cardiac *Gati Sangha* (electrical blockage) leads to AV conduction disturbances and atrial fibrillation, indicating direct blockage of APs in the bioelectrical circuitry of the heart.[22] From a neurohormonal perspective, *Oja Kshaya* (loss of vitality of the heart) refers to increased levels of BNP and loss of cardikines in heart failure.

3.6. The Heart-Axon Axis: A Unifying Translational Model

The Heart-Axon Axis offers a hexapodal approach as a basis for translational science (Table 3). The bioelectric conduction arm, *Mahajava* and *Prasarpana* of *Vyana Vayu*, corresponds to AP propagation through the cardiac Purkinje network and myelinated axons and can be assessed clinically using NCV and electrocardiogram. The afferent nervous arm corresponds to *Urdhva Gati* due to vagally-mediated cortical interoception. Efferent nerve arm corresponds to *Tiryak Gati* due to outflow of cardiopulmonary plexuses through autonomic function and can be assessed clinically using HRV. Humoral endocrine arm operationalizes governance of *Rasa Dhatu* through cardiokine secretion. The paracrine extracellular vesicle arm represents *Sukshma Srotas*, defined by inter-cellular communication through miRNAs contained in the cardiac extracellular vesicles. The higher CNS arm operationalizes *Vyana-Manovaha Srotas* interface in Heart-Brain Axis using HRV as the main clinical indicator.[23,24]

The theoretical underpinning of Thayer and Lane's Neurovisceral Integration Model (2009)[23] serves as the highest arm of this scheme: HRV serves as an indicator of prefrontal-autonomic nervous integration reflecting what, in *Ayurveda* terms, is described as *Vyana-Manovaha Srotas* conversation. High HRV suggests normal *Vyana Vayu* functioning; chronic low HRV suggests *Vyana Dushti* (Figure 2).

3.7. Therapeutic Approaches through a Biomedical Lens

Therapeutic Approaches viewed through a biomedical perspective. *Ayurvedic* treatments for *Vyana Dushti* can be reinterpreted based on their effects on bioelectrical and neurohumoral mechanisms. *Abhyanga* (medicated oil massage) modulates cutaneous sensory APs and enhances vagal tone through mechanoreceptor stimulation, diminishing sympathetic outflow and improving HRV. *Basti* (medicated enema) works on the gut-brain-cardiac axis to bring back the balance of enteric $Na^+/K^+/Ca^{2+}$, which is important for AP equilibrium, and it also changes the tone of the vagus nerve through the gut-vagal arc. *Shirodhara* increases HRV and vagal dominance by lowering the sympathetic drive in the cortex.

Arjuna (Terminalia arjuna), the principal *Hridya* (cardiac) remedy in classical *Ayurveda*, stabilizes cardiac ion channels (Na^+/K^+ ATPase), exhibits anti-arrhythmic properties through AP modulation, diminishes BNP levels in heart failure patients and enhances HRV, directly targeting both the bioelectrical (cardiac AP stabilization) and neurohumoral (cardiokine normalization) aspects of cardiac function of *Vyana Vayu* impairment at the *Hridaya*.[25] *Rasayana* formulations (*Ashwagandha, Brahmi*) rebuild *Oja* through neuroprotective and adaptogenic neurohumoral mechanisms with potential to restore myelin integrity and NCV on long-term use.

4. DISCUSSION

The most important contribution of this integrated analysis is showing that *Vyana Vayu* relates to two different but complementary biomedical areas at once. Previous work treated these as conflicting ideas. This framework reveals that they are complementary parts of a single integrated system called the Heart-Axon Axis. This dual nature is clear in the classical description, since *Vyana Vayu* drives neural impulses at *Mahajava,* which is the speed of APs, while also managing cardiac circulation and the distribution of neurohumoral signals known as cardiokine reach. Classical *Ayurveda,* which did not divide concepts in the way modern science does, explained a physiological reality that modern biomedicine is now reconnecting through neurocardiology.

This framework leads to four specific research directions. First, NCV and EMG can serve as objective measures of *Vyana Vayu*'*s* bioelectrical aspect, which can be directly used in clinical assessments. Second, HRV parameters, including root mean square of successive differences and the low-frequency/high-frequency ratio, assess the balance between the vagal and sympathetic systems of the neurohumoral aspect. This suggests creating a combined "*Vyana Vayu* Index" that merges both measures into a new integrative biomarker. Third, profiling cardiokines such as ANP, BNP and CGRP in patients with classical *Vyana Dushti* symptom clusters would establish reference ranges for biohumoral diagnosis. Fourth, prospective clinical trials of *Ayurvedic* therapies should use NCV, HRV and cardiokine panels as primary endpoints to thoroughly test their proposed bioelectrical and neurohumoral mechanisms.

The World Health Organization Traditional Medicine Strategy (2014–2023) supports the inclusion of proven traditional medicine concepts into evidence-based health systems.[26] Foundational Ayurvedic principles such as *Dinacharya, Ritucharya* and *Rasayana* have already demonstrated preventive value against lifestyle disorders that overlap clinically with the *Vyana Dushti* spectrum described here, lending further support to such integration.[27] The Heart-Axon Axis framework offers the conceptual structure needed for this objective in the cardiovascular-neurological field. However, it has a limitation due to the nature of conceptual analysis: functional comparisons lead to hypotheses but not to proof of cause. The next crucial step is to conduct experimental and clinical validation using standardized *Ayurvedic* assessment tools along with bioelectrical and neurohumoral outcome measures.

5. CONCLUSION

The classical description of *Vyana Vayu* begins in the *Hridaya*. It moves at *Mahajava*, spreads through all tissues and controls movement, circulation and sensory-motor integration. This description reflects a dual reality in biomedicine. At the bioelectrical level, it relates to the AP, which includes ionic gradients, depolarization kinetics, saltatory conduction and neuromuscular coupling. At the neurohumoral level, it connects to the Heart-Axon Axis, which encompasses ICNS autonomy, vagal-sympathetic bidirectional signaling, cardiokine secretion and exosomal communication between cells.

The Heart-Axon Axis is the first framework to bring these two areas together under one *Ayurvedic* concept. It offers a basis for clinical research driven by hypotheses using NCV, HRV and cardiokine biomarkers. This shows that ancient *Ayurvedic* scholars recognized through clinical observation, a systemic integration of bioelectrical and neurohumoral functions. Contemporary biomedicine is only now beginning to reconnect with these concepts. NCV and EMG assess it on the periphery, while HRV and cardiokine panels evaluate it centrally. The Heart-Axon Axis makes both types of measurements significant within a single physiological framework.

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All authors have read and approved the final version of the manuscript and equally contribute in forming the manuscript.

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11. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

12. DISCLAIMER/VIEW AND OPINIONS

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13. AI-USE DECLARATION

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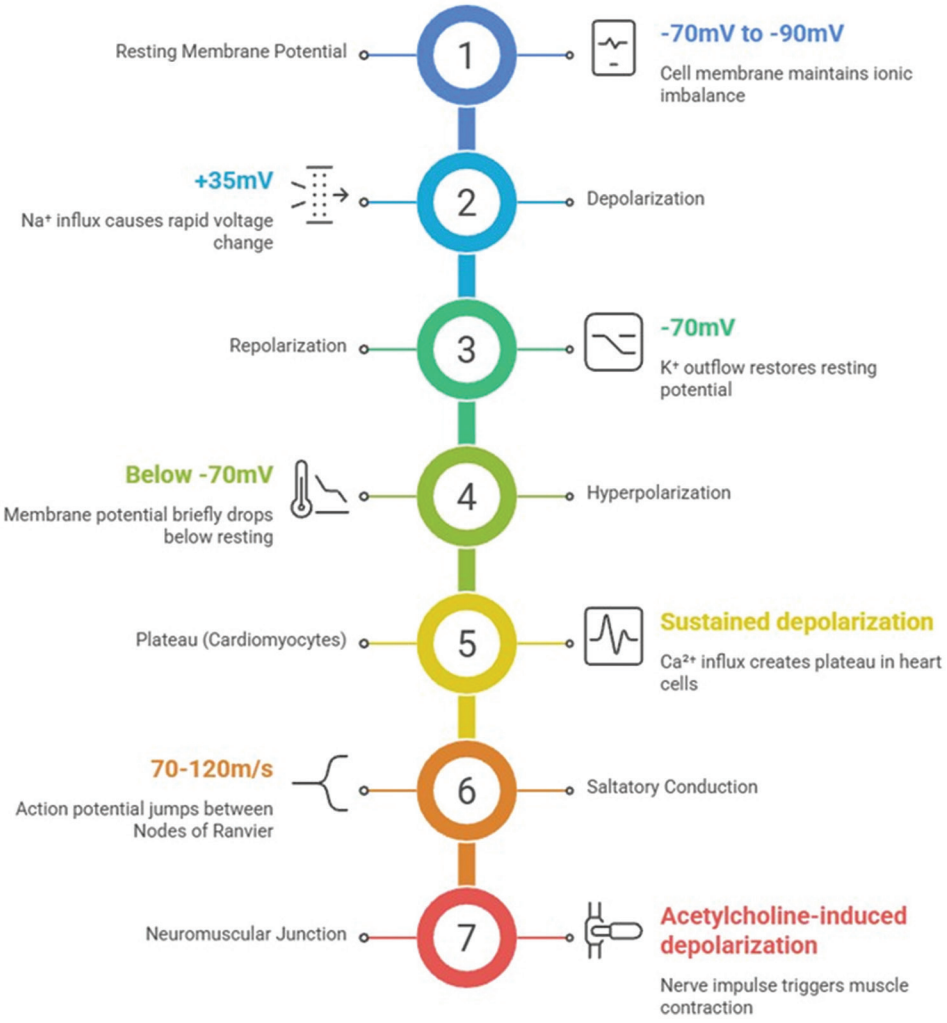

Figure 1: Biophysics of action potential and *vyana vayu*

Table 1: Classical features of *Vyana Vayu* along with their biomedical and neuro-humoral equivalents

Classical feature	Bioelectrical feature (AP)	Neurohumoral feature (Cardiac)	Functional integration
Sarvadeha-Chara (omnipresent spread)	Peripheral nervous system; saltatory axonal conduction	ICNS; cardiac plexus efferents; cardikines distribution	Dual-channel bioelectrical and neuro-humoral network in the systemic circulation
Mahajava (speedy conductance)	Na^+ entry dynamics; 70–120 m/s saltatory conduction	Baroreceptor-NTS autonomic reflex pathway conductance	High-speed bioelectrical and neuro-humoral conductance
Prasarpana/Akshepan (conduction and contraction)	AP conductance; excitation-contraction coupling; ACh-NMJ	Systolic-diastolic cardiac functions and HRV	Depolarization-contractility functional continuum
Indriya Karma (sensorimotor conductance)	Motor unit recruitment; NMJ reflex loop; NCV	Interoception; vagal afferent pathway; insular cortex	Viscero-somatic sensory-motor conductance
Rakta Vaha Srotas (cardiac governance)	Vascular smooth muscle AP regulation	ANP, BNP, CGRP; cardiac output regulation	Dual-regulation of cardiovascular function by neuro-humoral factors
Gati Sangha (conduction block)	Conduction block; demyelination; decreased NCV in EMG	Dysautonomia; AV block; decreased HRV	Bioelectrical and autonomic conduction block

ACh: Acetylcholine, ANP: Atrial natriuretic peptide, BNP: B-type natriuretic peptide, AP: Action potential, CGRP: Calcitonin gene-related peptide, HRV: Heart rate variability, ICNS: Intrinsic cardiac nervous system, NCV: Nerve conduction velocity, NMJ: Neuromuscular junction, EMG: Electromyography, NTS: Nucleus tractus solitarius

Table 2: *Vyana Dushti* and associated bioelectrical and neurohumoral pathological correlates

***Vyana Dushti* (Diseases caused due to disturbance *in Vyana*)**	***Ayurvedic* conceptual basis**	**Bioelectrical correlate**	**Neuro-humoral/Cardiac correlate**
Suptata/Stambha (numbness/stiffness)	*Avarana* (blockage) of *Vyana Vayu*	Decreased NCV; demyelinating peripheral neuropathy; prolonged distal latency	CAN
Kampa (tremors)	Irregular *Vyana Vayu*	Ectopic discharge APs; EMG tremors	Arrhythmias; HRV instability
Vaikruta Gatih (disordered movement)	*Prasarpana-Akunchana* incoordination	Conduction blocks; abnormal EMG motor recruitment pattern	Orthostatic hypotension; dysautonomia
Hridroga (abnormal cardiac rhythm)	Blockage of *Vyan Vayu* within *Hridaya*	AV block; SA node dysfunction; ECG changes	Atrial fibrillation; heart failure
Oja Kshaya (vital depletion)	*Dhatu Kshaya* (cardiac weakness)	Reduced AP amplitude; myopathy on EMG	↑BNP; cardiokine deficiency; immune dysregulation

↑BNP means increased B type natriuretic peptide. AV: Atrioventricular, BNP: B-type natriuretic peptide, CAN: Cardiac autonomic neuropathy, HRV: Heart rate variability, NCV: Nerve conduction velocity, ECG: Electrocardiogram, EMG: Electromyography, SA: Sinoatrial

Table 3: Components of the Heart-Axon Axis under ayurvedic and biomedical paradigms

Axis arm	**Ayurvedic component**	**Biomedical correspondence and function**
Bioelectrical conduction	*Mahajava; Prasarpana*	AP transmission in Purkinje system and peripheral myelinated nerves; NCV is used as an indicator
Afferent neural	*Urdhva Gati* (upward flow)	Afferent vagal fibers (80–90%) project to NTS and then to insular cortex (interoceptive processing)
Efferent neural	*Tiryak Gati* (peripheral spread)	Sympatho-vagal innervation (cardiac plexus); HRV serves as an indicator of autonomic tone
Humoral endocrine	*Rasa Dhatu/Rasa Vahini Srotas*	Cardiokines (e.g., ANP, BNP, CGRP, FGF21); systemic neuroendocrine regulation
Paracrine exosomal	*Sukshma Srotas* (subtle channels)	Cardiac exosomes with miRNA (miRNA-21, miRNA-126) content acting on an epigenetic level (intercellular signaling)
Higher CNS	*Manovaha Srotas and Vyana Vayu*	Heart-brain axis; insular cortex and prefrontal autonomic modulation

ANP: Atrial natriuretic peptide, BNP: B-type natriuretic peptide, CGRP: Calcitonin gene-related peptide, HRV: Heart rate variability, ICNS: Intrinsic cardiac nervous system, NTS: Nucleus tractus solitaries, CNS: Central nervous system, NCV: Nerve conduction velocity, AP: Atrial potential, FGF21: Fibroblast growth factor 21, miRNA: Micro RNA

Figure 2: The heart axon axis: A hexapodal translational model