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Ultrasound Doppler Study of Distal Radial Arterial Pulse (*Naadi*) for various pulse characteristics in *Vataja Naadi, Pittaja Naadi, Kaphaja Naadi* and *Sama Naadi*– A cross-sectional pilot study

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ABSTRACT:

Introduction: Arterial pulse-based diagnostics is an age-old diagnostic technique used worldwide. One of the most effective non-invasive diagnostic methods for assessing the condition of the distal radial artery (DRA) profile is ultrasound Doppler examination in B-mode. The purpose of this study was to measure the DRA's pulse wave velocity (PWV) and resistive index (RI) in various pulse patterns. **Methods:** This was a cross-sectional pilot study. A total of 36 healthy volunteers between the ages of 18 and 35 years participated in this pilot study. To begin the examination, the hand was semiflexed for the palpatory approach by an *Ayurvedic* doctor who performed the palpatory test had extensive training in *naadi pariksha*. *Dosha* expressions were recorded at the index, middle, and ring fingers. In the second test: the ultrasonography (USG)-B mode study of same patients was done within 10 minutes of the palpatory test on the distal radial arterial pulse, by a radiologist who was blinded to the results of palpatory *naadi* examination. RI, PWV, radial artery diameter, and intima media thickness were the measures of the DRA pulse gathered with USG of DRA. One-way ANOVA was used to statistically analyse the relationship between *naadi* type and USG parameters at the $P < 0.05$ (5%) level of significance. **Results:** Compared to *pittaja naadi* (0.802 ± 0.10), *kaphaja naadi* (0.640 ± 0.17), and *sama naadi* (0.6938 ± 0.28), *vataja naadi*'s resistance index (0.5019 ± 0.20) was noticeably lower. In comparison to *pittaja naadi* (0.882 ± 0.70 mm/sec), *kaphaja naadi* (0.651 ± 0.45 mm/sec), and *sama naadi* (0.51 ± 0.24 mm/sec), *vataja naadi's* PWV(pulse wave velocity) was low 0.474 ± 0.3 mm/sec. **Conclusion:** Distinct *naadi* patterns are linked to variations in blood flow properties. Hence, the technological framework of the ultrasonic Doppler method for RI and PWV made this examination more objective for the researchers and students.

KEYWORDS: Distal radial artery, *naadi,* pulse wave velocity, resistive index

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1. INTRODUCTION

In the thirteenth century BC, pulse testing was described as one of the diagnostic tools in *Ayurvedic* literature. [1] The *vata dosha* serves as a motivator and governs the functions of nerves, ion balance, gas exchange, as well as the transportation of nutrients throughout the body, peristalsis, and both sensory and motor activities. The *pitta dosha* is in charge of digestion, metabolism, and energy generation, and it regulates the body's temperature. The *kapha dosha* contributes to the formation of the body's structure, the stability of cell organelles, and maintains the integrity, strength, and immunity of tissues and organs. [2]

The arterial pulse characterized by *vata dosha* exhibits a normal sinus rhythm, a lower/faster pulse rate (as per its association with *kapha* and *pitta* respectively), with deep in pulsation and thin pulsations with reduced blood volume, and a short pulse quality (curves). The pulse characterized by *pitta dosha* also maintains a normal sinus rhythm but has a faster pulse rate, which can be palpated at a superficial level without any pressure exerted by the examiner with normal blood flow volume, with large pulse-wave curves. The physiological *kaphaja* pulse has a normal rhythm, less pulse rate, deep but thick in pulsations with normal blood volume, and large pulse character (curves). In *Sama naadi* type, there is balanced functioning of three *dosha*; hence the physiological *sama naadi* has normal rhythm, rate, and normal volume, with stable curvatures in the systolic and diastolic phases of the pulse. The pathological arterial pulse has an irregular rhythm and sharp large pulse characteristics with either low or very strong blood volume. [3]

The qualitative and functional statuses of doshas are assessed in *naadi* (arterial pulse). Clinical medicine accepts *naadi pariksha* (arterial pulse examination) as a fundamental element of diagnosis. Palpation of the pulse was the crown of the Royal College of London, which was established to improve the scientific basis and practice of medicine. [4] There are various physiological factors such as emotional stress, anxiety, sleep, food intake, activities, and natural urges which affect the *naadi* patterns which are variables affecting the physiological status of *naadi*. The pathological factors such as infections, inflammations, and blockages/occlusions at any site of the body, can cause abnormal pulse wave presentations. Based on the physiological *naadi* presentation (blood vessel behavior and flow characteristics), there are seven types of *naadi* explained in *Ayurveda* literature – *Sahaja vataja naadi, Sahaja naadi, Sahaja kaphaja naadi, Sahaja vatapittaja naadi, Sahaja vatakaphaja naadi, Sahaja kaphapittaja naadi, and Sahaja sannipataja naadi*. [5] In *prakopa avastha* (aggravated dosha), the *vataja naadi* is characterized with irregular and instable movements like snake, the pittaja naadi moves with higher vibration and jump like frog, quail, the *kaphaja naadi* moves much heavier and slower like elephant. [6]

Passing on the skills and knowledge of this subjective diagnostic method is challenging, but pulse imaging techniques are utilized to validate the diagnosis, revealing potential interpretations of various *naadi* types. Therefore, technology can be utilized to measure

factors such as *naadi* and the state of *dosha* in the body. [7] Ultrasound Doppler has emerged as a non-invasive, feasible tool to study vascular mechanisms. There are various pulse parameters like resistive index (RI), pulsatile index (P.I), arterial luminal diameter (LD), intima media thickness, systolic and diastolic ratio, and pulse wave velocity (PWV) which can be obtained with ultrasound Doppler. [8] There are various studies on pulse diagnosis using various types of sensors such as piezoelectric, piezo resistive, stain-gauge sensors, and hall sensors. Significant progress in technology will fill the gaps between classical theories and modern concepts thus creating an evidence-based scientific concept. [9] Many studies are stimulation studies and reviews studies and hence, a real-time imagining on healthy volunteers was done using ultrasound Doppler 3 Hz to study the distal radial arterial pulse (*naadi*) characteristics.

Objectives: The study aims to find the technical interpretation of different characteristics of the distal radial arterial pulse. Further, to study the difference in RI, P.I, Arterial LD, Intima media thickness, Systolic and diastolic ratio, and PWV across *Vata sthana Pitta sthana* and *kapha sthana* of the radial artery. Further to find the association of the Ultrasonography (USG) pulse parameters with palpatory *naadi* type. The pre-specified hypotheses of this study was the *naadi pariksha* which was believed as subjective examination was interpreted using USG Doppler and thus establishing the scientific objective parameters for research and documentation of *naadi* type. This pilot study would be fundamental study for development of a further prototype of *naadi* diagnosing instrument.

2. METHODS

Study design and settings and period of recruitment: This was a cross-sectional pilot study conducted in the department of radiology under the guidance of a radiologist, from February 2021 to March 2021, reported as per STROBE guidelines.

Ethical clearance: This study has obtained university ethical clearance KAHER/Ethic/2018-19/D-124 along with CTRI registration CTRI/2021/04/032940.

Study participants: Non-randomly selected apparently 36 healthy volunteers of the age group 18–35 years who were not on any medications, and who have given their written consent were included in this study.

Inclusion criteria:

- Healthy volunteers both of male and female gender who were physically healthy
- Subjects didn't take any regular medications
- Subjects did not have any complaints
- Subjects having proper hunger, natural urges, sleep, and enthusiasm
- Subjects having no physical disabilities of hand

Exclusion criteria:

- The patients with a history of medication for any chronic illness like hypertension, diabetes, asthma, cardiac ailments which could alter the pulse parameters.
- Pregnant woman, lactating mothers, and women in menstruation.

Among 40 volunteers screened with palpatory *naadi pariksha*, but further in ultra-sound doppler– B mode

with 3 Hz probe, 4 radial artery profiles could not be captured due to the low volume of the arterial pulse, hence these participants were excluded and considered as dropouts.

Sample size: Since this was a pilot study, we were not p-value centric and instead concentrated on descriptive statistics (means, standard deviations, categorical values, and continuous values). The sample size of 95% of the CI for one sample fraction is justified based on the 95% CI of the mean and a 5% error margin. The formula is $p \pm 1.96\sqrt{[p(1-p)/n]}$, where n is the sample size and p is the estimated proportion. A pilot study of sample size 36 participants was taken for 0.95 CI for 1 sample proportion. [10]

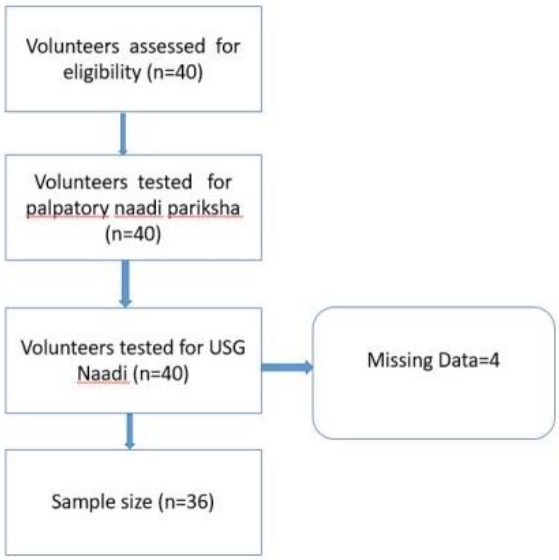

Figure no.1: Flow diagram of participants

Procedure: The participants' willing for the study and had given written consent, were given basic guidelines like of being relaxed 10 minutes before examination, not using their mobile phones nor doing any strenuous work just before or during the examination. The volunteers were explained about the procedure in their own language a day prior and they were explained about the study procedure. The volunteers were informed to complete their routine natural urges such as urination and defecation. The patient was instructed to arrive for the examination on an empty stomach, abstaining from both food and water. This study was conducted in the morning 8 am–11.00 am. Distal radial artery (DRA) (*naadi*) was examined manually with the standard three-finger examination method. The palpatory examination was done by Ayurveda physician, well trained in *naadi pariksha*. In palpatory methods, a standard case performa validated with 5 point Likert scale was validated from two external and 2 internal experts was used.

Naadi Pariksha (Palpatory Pulse Examination): The DRA pulse of the left hand (in female volunteers) and right hand (in male volunteers) was examined manually. The investigator placed his right index finger below the radial styloid on the radial artery. The middle and ring fingers were placed next to the index finger. The position of the radial artery was examined in semiflexed position. Normally felt over the radial bone 1 angula (1.37 inches away from wrist joint) ascending in *vata sthana* – index finger, *pitta sthana* – middle finger, and *kapha sthana* – ring finger). [11] In immediate expression without pressure on the artery, for 1st minute–the anatomical position of the radial artery (*sthana*) and the condition of the blood vessel wall (*katinya*) was noted. Figure no.1, In 2nd minute, the rate per minute, rhythm was noted, In the 3rd minute, *dosha* expression at index finger, middle finger, and ring finger were noted. Parameters such as *gati* (pulse rate), *tala* (rhythm), *sthana* (position), *bala* (volume), and *dosha*

avasta were collected and analyzed for *naadi* type. This *naadi* palpatory examination was performed on a volunteer for totally 3 minutes at the screening space near the USG room; within 2 minutes-5minutes the volunteer was examined for USG of distal radial arterial pulse. [12] As per the classical literature, the *sahaja vata naadi* is *sukshma* (thin in palpation), *dhavayati* (swift in movement), *soumya* (without high pressure), in the *sahaja pittaja naadi sheegra* (rapid/fast), *dheerga* (prolonged amplitudes of pulse pressure), the *sahaja kaphaja naadi* is *manda (slow), guru* (full volume). An algorithm was developed based on the classical literature to diagnose the *naadi* type [Table 1].

Table 1: Characteristics of the different *naadi* types [13]

Pulse	Vataja Naadi	Pittaja Naadi	Kaphaja Naadi	Sama Naadi
Location	Radial artery below radial styloid 1.37 inches from wrist joint	Radial artery below radial styloid 1.37 inches from wrist joint	Radial artery below radial styloid 1.37 inches from wrist joint	Radial artery below radial styloid 1.37 inches from wrist joint
Characteristics	Fast, feeble, thin, disappears on pressure	Prominent, strong, high amplitude, forceful, lifts palpating finger	Deep, slow, broad, wavy, thick	Moderate speed, good blood flow volume, moderate amplitude
Blood vessel consistency	Elastic thin, deep in palpation	Elastic soft, superficial in palpation	Elastic thick deep in palpation	Elastic thick superficial in palpation
Movement (*gati)*	The sensation is like a snake's curved scrawling for a high level of vata with swift and light pulsation	Sensation like a frog jumping under the middle finger, strong and forceful, bounce, powerful pulsation	Sensation like pigeon, swan smooth and slow movement felt, glide, floating pulsation	The sensation is like Swan, elegant slow movement felt
Rhythm (tala)	Regular	Regular	Regular	Regular
Force (bala)	Low	High	Moderate	Moderate
Rate (vega)	50–70	80–100	50–70	70–76

Figure 2: The examination sites for *vata sthana, pitta sthana, and kapha sthana*

Ultrasound Doppler method to obtain the *naadi* (distal radial arterial) data: The USG – B mode, with a probe of 3 Hz was used to study distal radial arterial pulse parameters by radiologist in the USG scan center of KLE hospital who was single-blinded and did not know the *naadi* type. Parameters of distal radial arterial pulse such as RI and PWV were collected. Further without much time gap, the RI and PWV of the DRA were noted using an ultrasound Doppler of 3 hz by an expert

radiologist. The transducer was kept on transversely on DRA, such that it measures the arterial blood flow behavior in 3 points separately (marked 1.37 inches away from wrist joint ascending in *vata sthana* – index finger site, *pitta sthana* – middle finger site, and *kapha sthana* – ring finger site without any gaps) subsequently as shown in Figure no.2 Figure no.3, figure no.4. Three-point data of the radial arterial pulse was collected only once. The parameters like RI, LD, intima media thickness, and PWV were noted in all 3 points (*vata sthana, pitta sthana,* and *kapha sthana*). The grading of the parameters was done considering the physiologically normal data [14][15][16] and available data of the present study (range between the highest and lowest values of the data obtained). The RI from 0.1 to 0.5 was low, >0.5–0.8 was medium, and >0.8 was high. The PWV 0.1–0.5 mm/sec was slow, >0.5–0.8 was medium, and >0.8 was fast. The USG parameters of the three points (*vata sthana, pitta sthana*, and *kapha sthana*) were analyzed for low or medium or high ranges. These parameters were correlated with the *Ayurveda* parameters of *naadi*. The *vega* can be correlated to PWV, the *tala* of *naadi* is compared to rhythm, the bala can be compared to RI as shown in Table no. 2 and Table no.3.

Table no.2 Correlation of *Naadi* parameters with Ultrasonography parameters [14],[15],[16]

Pulse wave Parameters		**Gradings**		
Arterial diameter	Mean diameter of radial artery 2.36± 0.41mm. [14]	Long (>1.1mm)	Medium (0.51-1mm)	Short (0.1-0.5mm)
***Katinata* (Intima media Thickness)**	Thickness of the arterial wall 0.25± 0.04mm	Thick (0.18-0.26mm)	Medium (0.09-0.17mm)	Thin (0.01-0.08mm)
***Vega* (Pulse wave Velocity)**	The velocity at which the blood pressure pulse propagates through an artery. 0.7-0.9mm s(-1). [15]	Fast >1.7 mm s(-1)	Medium 0.81- 1.6mms(-1)	Slow 0.1-0.8mms(-1)
***Bala* (Pulse wave R.I (resistive index)**	The **resistive index** derived from the maximum, minimum, and mean Doppler frequency shifts during a defined cardiac cycle. 0.40±0.06. [16]	High (>0.8)	Medium (0.41-0.8)	Low (0.1- 0.4)

Figure 3: The USG naadi recording

Figure no.4: The USG recording of *naadi* by Radiologist

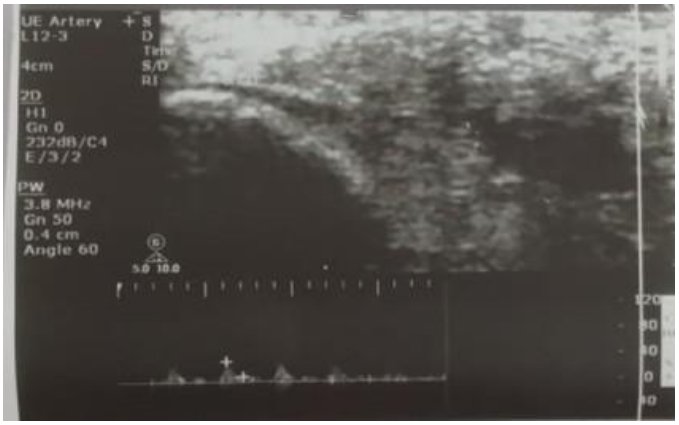

Figure no.5: The ultrasonography of radial artery

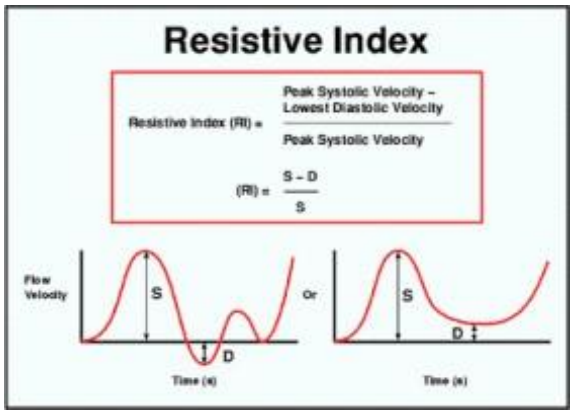

Figure no.6: Resistive Index of Pulse

Statistical analysis:

The data obtained from the standard three-finger examination method were analyzed to interpret the type of pulse wave pattern and the ultrasound Doppler method was analyzed using descriptive statistics like mean and standard deviation of the pulse parameters to study the range of the values and further one-way analysis of variance (ANOVA) was used at 0.05 (5%) level of significance using SPSS software version 10 manufactured by IBM Corp. Chicago, United states to study the difference between and within the groups. As there were more than two groups, one-way ANOVA was used at 0.05 (5%) level of significance to test normality and homogeneity of variances. Additional statistically powered tests, such as *post hoc* power analysis, were performed using Dunnett's multiple comparison to identify significant differences using one-way ANOVA.

After cleaning up the data from 40 volunteers, the data from five volunteers who had missing data (dropouts) were not analyzed. With a sample size of 36, the four groups – *Vataja Naadi, Pittaja Naadi, Kaphaja Naadi, and Sama Naadi* – were analyzed for palpatory *Naadi Pariksha* (rate, rhythm, blood vessel consistency, and pulse pressure) and USG parameters (LD, intima media thickness, RI, and PWV). According to the study hypothesis, the null hypothesis is correct if there is no variation in USG parameters between *vataja, pittaja* and *kaphaja naadi* types (within the group) and no correlation between USG parameters and palpatory parameters (between the groups). The alternate hypothesis was there is variation across *vataja naadi, pittaja naadi,* and *kaphaja naadi* (within group), with further association in USG parameters with palpatory parameters (between the group).

RESULTS: Among 40 volunteers screened with palpatory *naadi pariksha*, but further in ultra-sound doppler– B mode with 3 Hz probe, 4 radial artery profiles could not be captured due to the low volume of the arterial pulse, hence these participants were excluded and considered as dropouts.

Healthy volunteers (*n* = 36) fulfilling the inclusion criteria were divided into 4 categories namely 10 *vataja naadi* (28.5%), 9 *pittaja naad*i (25.71%), 12 *kaphaja naadi* (34.28%), and 5 *sama naadi* (11.42%). Distribution of volunteers as per the different distal radial arterial

pulse (*naadi)* characters' types, resistive index and pulse wave velocity is as shown in Table no.3

Table 3: Distribution of *naadi* types and resistive index, pulse wave velocity, Luminal diameter, IMT

Naadi type	n * (%)	RI‡ Mean SD†	PWV § Mean SD (mm/s)	LD¶ In mm||	IMT**in mm
Vataja	10 (27.7)	0.5019±0.207	4.7346±3.04	0.14±0.04	0.05±0.01
Pittaja	9 (25)	0.8020±0.1000	8.8255±7.01	0.17±0.02	0.03±0.01
Kaphaja	12 (33.33)	0.6404±0.1710	6.5194±4.54	0.15±0.05	0.06±0.02
Sama	5(13.88)	0.6938±0.286	5.100±2.41	0.15±0.02	0.03±0.02
Total	36 (100)				

*n-Number of volunteers (%) **,** †SD: Standard deviation, ‡RI: Resistive index, §PWV- pulse wave velocity, || millimeters, ¶LD-Luminal diameter, ** IMT-Intima media thickness

The RI of the DRA of the healthy volunteers presented that the average RI in *vataja naadi* was 0.500, *Pittaja naadi* was 0.802, *kaphaja naadi* was 0.6404, and *sama naadi* was 0.6938. The PWV of the DRA of the healthy volunteers showed that the average PWV in *vataja naadi* was 4.7346 mm/s, *Pittaja naadi* was 8.8255 mm/s, *kaphaja naadi* was 6.5194 mm/s, and *sama naadi* was 4.8500 mm/s as shown in Table no.3

The RI of the DRA at the three points namely the *vata-sthana, pitta sthana*, and *kapha stahana* were observed as presented in Table no. 4.

Table 4: Average resistive index in vata, pitta, and kapha sthana of distal radial artery

Type	*Vata sthana*	*Pitta sthana*	*Kapha sthana*
Vataja naadi	0.46780	0.51400	0.52400
Pittaja naadi	0.82622	0.80478	0.77500
Kaphaja naadi	0.65675	0.65108	0.61350
Sama naadi	0.54900	0.81675	0.71575

The PWV of the DRA at the three points namely the *vata-sthana, pitta sthana*, and *kapha stahana* were observed as presented in Table no.5

Table no. 5: Average pulse wave velocity in *vata, pitta, and kapha sthana* of distal radial artery

Type	*Vata sthana* (mm*/s)	*Pitta sthana* (mm/s)	*Kapha sthana* (mm/s)
Vataja naadi	4.6600	4.9220	4.6220
Pittaja naadi	7.7111	0.0500	10.5613
Kaphaja naadi	5.7358	8.1420	6.8450
Sama naadi	5.2750	3.7000	5.5750

*mm/s-millimeters/second

The obtained data were analyzed using SPSS Statistics Version 10. The pulse data were assessed for normality using the Kolmogorov–Smirnov test for RI and PWV which was found to be normally distributed. The mean values of the RI and PWV measured from *vata, pitta*, and *kapha* sites of the DRA were analyzed using one-way ANOVA followed by Dunnett T3 multiple comparisons ($P < 0.05$). There were significant different across the *vataja, pittaja, kaphaja,* and *sama naadi* types in RI, PWV, IMT as mentioned in Table no.6 across the 4 groups of *naadi* type at 5% level of significance. No difference was seen in Arterial luminal diameter across different naadi types.

Table no.6: Summary of one-way ANOVA results with *vataja naadi, pittaja naadi, kaphaja naadi, and sama naadi*

Parameters (average of all 3 sites of DRA†)	Mean square	df	Significance
Average RI*	0.145	3	0.011
Average PWV‡	0.302	3	0.046
Average IMT§	0.291	3	0.045

*RI: Resistive index, †DRA: Distal radial artery, ‡PWV: Pulse wave velocity, §-IMT initima media thickness

3. DISCUSSION

One of the superficial arteries, the DRA (distal radial artery), was studied to determine the body's *vata, pitta*, and *kapha dosha* states. Pulse factors such as *gati* (movement), *vega* (rate), *tala* (rhythm), *bala* (force), *tapamana* (temperature), *akruti* (volume), and *katinya* (blood vessel consistency) are parameters mentioned in *Ayurveda*. [13] The RI of the pulse in this study is the impedance (or resistance to blood flow) in the artery, which indicates the *akruti* (volume and tension of blood flow). The radial artery's resistance index is approximately 0.40 ± 0.06. [17] The second parameter being the PWV, the speed of the pulse which can be compared to *naadi bala*(force). The present study included the adult population of the age group ≥23 ± 5 years who visited the study site and had given their written consent for the study. The adult age group was selected as the cardiovascular and arterial parameters are similar to the specific age group. [18], [19] The normal pulse-wave velocity of the radial artery is around 8.7 ± 4 mm/s.[20] The sample size of 35 volunteers was adapted as mentioned in the *Z*-test to fulfill the normal distribution. The volunteers whose pulse data could not be captured by ultrasound Doppler method or palpatory method were excluded from the study. The study maintained a controlled environment where the volunteers were asked to relax for 10-15 minutes to avoid any bias in the obtained data. The volunteers were counseled to attend to all their natural urges, no eating, no drinking, no laborious activity, or emotional stress during the period of palpatory examination followed by an ultrasound examination. The RI is the resistance to the blood flow calculated with the difference of systolic velocity by diastolic velocity which is further divided by the systolic velocity. The RI is directly proportional to the arterial pressure and corresponds to the endothelial function. [20] In the present study the RI in *pittaja naadi* (0.802 ± 0.1) is more when compared to *sama naadi* (0.693 ± 0.28), *kaphaja naadi* (0.64 ± 0.17), and *vataja naadi* (0.501 ± 0.2). Hence, *vataja naadi* with thin blood vessel consistency and less pressure has less RI, and *pittaja naadi* with high pressure has the highest RI when compared to other *naadi* types. The PWV in healthy *pittaja naadi* is high (8.8 ± 0.7 mm/s) when compared to the *kaphaja naadi* (6.5 ± 0.45 mm/s), *sama naadi* (5.1 ± 0.24 mm/s), and *vataja naadi* (4.7 ± 0.3 mm/s). The One-way ANOVA showed a significant difference within the groups of *naadi* types through the USG Doppler group for RI 0.011 ($P < 0.05$) and PWV 0.046 ($P < 0.05$). The effect of diurnal variations of *dosha* was not included, and as per the feasibility, the pulse data were collected from 8 am to 11 am.

Earlier studies have reported on the digital volume pulse acquired using PPG composed of reflected waves. By the effect of the reflected wave, a peak appears in the

diastolic phase (diastolic peak). The time interval between the systolic peak and diastolic peak is proportional to the total path length of the pulse wave. The RI is the ratio of systolic and diastolic peaks. [21] In this era of evidence-based science there is a need to quantitate and assess pulse parameters with the help of new technologies. Venkata *et al*. in their studies on *nadi pariksha* have correlated the Ayurveda literature, hemodynamic, and technological terms like PWV, arterial stiffness, and pulse rate variability. The variations of speed, stability, and overall pattern of *naadi* movement (*gati)* along with the aggravated doshas and their detection are a skill and science by its own. [22] Another study by Venkata *et al*. measured the stiffness index (S.I) and RI using pressure transducers of *naaditarangini* across tridosha locations. The *vata dosha sthana* had S.I 5.768 ± 1.13, which is the least when compared to the *kapha sthana* 8.34 ± 2.9 and *pitta sthana* 9.28 ± 3.63. [23]The artery will be hard like a string in *vata* dominance which has to show increased arterial stiffness when compared to *kapha* and *pitta dosha*. As age progresses, the *vata* dosha increases in the body; hence, the arterial vessels become harder and PWV increases.

The present study observed *vata dosha sthana* had RI 0.84 ± 0.075, which is the least when compared to the *kapha sthana* 0.95 ± 0.035 and *pitta sthana* 0.94 ± 0.048. Hatice Nursun *et al*. in their studies on radial and ulnar artery evaluation in carpal tunnel syndrome described the radial artery blood flow 61.28 ± 24.29, diameter 2.43 ± 0.18 mm, RI 0.74 ± 0.09 in normal position. The radial artery blood flow was 43.20 ± 29, diameter 2.62 ± 0.39 mm, RI 0.91 ± 0.11 in the semi-flexed position. The radial artery blood flow was 39.80 ± 22, diameter 2.43 ± 0.18 mm, RI 0.84 ± 0.06 in reverse Phalen position. These studies show that there are slight changes observed in the pulse profile and blood flow in hands with the position of the hand. [24] Earlier studies by Melanie *et al*. have stated that the resistivity index in healthy controls was observed at 0.6 ± 0.045, (P = 0.001) and diabetic children at 0.72 ± 0.1. [25] Sanu *et al*. in their studies on DRA dimensions using ultrasound Doppler method have mentioned the intima-media thickness and LD of the radial artery in different body constitutions. [26] Lisheng Xu *et al*. in their research observed that there are seven pulse patterns among which four are rhythmic: swift pulse (P.I ≤0.5 s), rapid pulse (0.5< mean P.I ≤0.7 s), moderate pulse (0.7< Mean P.I ≤1.1 s), and slow pulse (>1.1 s), and three are arrhythmic pulse patterns: running pulse (P. I ≤0.8 s and recurrent degree <3), knotted pulse (P.I >0.8 s and recurrent degree <3), and intermittent pulse (recurrent degree ≥3). [24]

In contemporary physiology, the pulse can be felt in the radial, carotid, femoral, brachial, and ankle arteries, where the pulse rate, volume, and rhythm are assessed. [27]Ayurveda highlights the examination of temporal and nasal arteries in addition to the superficial arteries noted by conventional medical science. [28] The radial artery and ulnar artery together, form the blood supply network of the hand to form the palmar arch derived from the radial artery which supplies the first two digits, and the superficial palmar arch derived from the ulnar artery supplies the third, fourth, and fifth finger. The

vasomotor activity of the hand is controlled by the sympathetic nervous system which is dominated by the median nerve. [29] The significance of the radial artery was well understood by the ancient physicians as easy to palpate and signifies the state of *doshas* all over the body hence the name *"jeeva naadi"* was given to radial artery. [30] Studies by Jyeshtharaj computed *jataraagni* (digestive fires) using *naadi pariksha* in different *ritus* (seasons) and its variations across *prakriti* types. [31] Hence in today's world, diagnosing based on the arterial pulse is becoming more grounded in evidence and scientific principles, supported by advanced technology for pulse measurement. Therefore, this study aimed to utilize technical assistance in assessing the pulse profiles of various *naadi*. The outcomes of this research would contribute to future studies and clinical assessments, further enhancing the objectivity and evidence-based nature of *naadi* diagnostic examinations.

Limitations of the study: Although in this present study, there was limitation of sample size as this was a pilot research work done to test associations of radial artery palpatory classical parameters with USG parameters. As this study was in collaboration with the radiology department which had lot of patient inflow, there could not be test–retest procedure to check the reliability of the USG machine. Hence, single-time palpatory and USG data was collected. The study can be conducted with increased sample size, with gender based analysis which can demonstrate better results which is limitation of the study.

Implications: This was a preliminary research conducted to study the co-relation of traditional *naadi pariksha* parameters with ultrasound Doppler parameters

4. CONCLUSION

The *tridosha* form the foundation for understanding the pathophysiology that occurs within the body. The conventional three-finger examination technique, being subjective, had several gaps in its teaching, documentation, and research processes. The findings related to the RI and PWV in the *dosha*-dominant *naadi* revealed a correlation between the palpatory *naadi* assessment and the ultrasound Doppler examination of the *naadi,* making this examination more objective and clear for learners and researchers. Therefore, the objective evaluation of *naadi* parameters through the ultrasound Doppler method was achieved.

Abbreviations:

USG-Ultrasound Doppler

DRA-distal radial artery

RI-resistive Index

PWV- Pulse Wave Velocity

PPG-Photo plethysmography

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