

**Association of handedness with foot and eye preferences with hair whorl direction****Vishram Singh<sup>1</sup>, Ruchira Sethi<sup>2</sup>, Rahul Rai<sup>3</sup>**<sup>1</sup>**Professor, Department of Anatomy, Santosh Medical College and Hospital, Ghaziabad**<sup>2</sup>**Professor, Department of Anatomy, Heritage Institute of Medical Sciences, Varanasi**<sup>3</sup>**PhD Scholar, Department of Anatomy, Santosh Medical College and Hospital, Ghaziabad****Received: 11-08-2020 / Revised: 15-09-2020 / Accepted: 21-10-2020****Abstract**

Handedness is well accepted markers of cerebral asymmetry with approximately 90% of general population being right handed and 10 % being left handed. The control centre of each hand is present contra laterally in the two cerebral hemispheres indicating the right hemispheric control left hand and vice versa. Both right and left handed individuals differ not only in cerebral dominance but also in certain habitual and behavioral patterns. Thus in the study on attempt is made to assess the association of handedness with foot preferences and also in direction of in an individual hair whorl. In 71.4% of right handed individuals exhibited right foot preference while in 64.3% of left handed individuals, left foot preference was observed while in case of eye preference the percentage was 76.3% and 64.7% in right and left handed individuals respectively. The association of handedness with respect to foot and eye preference was statistically significant. Such significant relationship between handedness and hair whorl direction was not observed.

**Keywords:** Handedness, footedness, eyedness, hair whorl

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**Introduction**

Laterality can be observed in paired organs like hand, foot, eye and ear or in similarly arranged non paired organs [1]. Laterality can also be crossed which indicated that the individuals prefers to use one part of the body for performing one task. As for example, when a person uses right hand for writing and left foot for kicking, the person is said to have crossed laterality [2]. However laterality may be undefined too, which means that there is no preference in using right or left side of the body. When the person exhibit harmonic specialization on the use of the body parts, then laterality may be termed as complete left dominance or complete right dominance [3].

The term handedness, footedness, or eyedness signifies the preference with which an individual uses specific hand, foot, or eye for trained activities that requires special coordination and skill [4].

In human population, about 90% of the individuals are right handed, 80% are right footed, 70% are right eyed and 60% are right eared. Similarly 10% of individuals are left hander, 20% are left footed, 30% are left eyed and 40% are left eared [5]. Some individuals exhibit cross dominance which means that the dominant hand, foot, or eyes are not of same side [6].

Previous studies have shown that 20% of individuals prefer use of hand and eye of opposite sides [7]. It is also reported that 1.5%-6% of right handed individuals prefer left foot, while 20-50% of left handed individuals prefer right foot [8]. Increasing evidence suggest handedness to be better determinant of brain dominance. However studies have also shown that footedness can predict language and cognitive abilities better than handedness especially in cultures where hand preference is much biased towards more use of right hand [9].

The functional asymmetries of brain are often derived from central or direct and peripheral or indirect measures of asymmetry. These measures show different degree of responses at perceptual and motor level. The peripheral measures involve hand and foot preference and performance in the motor level or

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domain while eye and ear preference in perceptual level or domain [10]. Hand preference is the most recognizable measure of asymmetry, of all and has been abundantly focused by many researchers. Thus present study was done to study foot and eye preference and direction of hair whorl in terms of handedness. It also shows the association of laterality markers with each other.

#### **Materials and methods:-**

**Study participants:** Total number of participants were 600 of which 300 were right handed and 300 were left handed. The participants were randomly selected from different schools and colleges.

**Study duration-** 2015-2020

**Study place:** Department of Anatomy, Santosh Medical College & Hospital, Ghaziabad in collaboration with Department of Anatomy, Heritage Institute of Medical Sciences, Varanasi.

#### **Inclusion criteria**

- Individuals of age group 3-20 years who consented for participation

#### **Exclusion criteria-**

- Individuals with gross deformity
- Individual who could not give consent

#### **Study procedure**

The participants and their parents were briefed about the intended study and the protocol to be followed. After obtaining consent form the participants and ethical approval from institutional ethical committee, the study was initiated. Handedness was assessed by Edinburgh Handedness Inventory [11]. The participants were instructed to perform the activities such as: handling of eraser, striking a match, hammering, brushing teeth, throwing, thumb taking, using scissor, holding knife.

The responses from each participant were recorded and scores were given. The score for handedness ranged from +1, 0 and -1. The score of +1 was assigned if the participant showed a right handed response while a score of -1 was given if a participant showed left handed response while score of 0 indicated the response either with hand i.e. right hand response or left hand response. The score obtained the participants were summed to obtain a scale and analyzed for handedness. The range of scale was +10 to -10. Based on the scale, the participants were categorized to three groups such as right handed, left handed and ambidextrous as:-

Right handed if the score ranged between -4 to +7

Left handed if the score ranged between -10 to -5

Ambidextrous if the score ranged between +8 to +10

#### **Assessment of Footedness**

Footedness was assessed by Chapman Foot preference Inventory [12]. The participants were categorized as right footed, left footed or either. The participants were first instructed to perform foot related activities such as kicking a ball, step on spade, hop, stamp on object, pick up object with, stepping forward, step upon stool, uppermost leg on crossing, putting on first shoe and stand on one's foot. The response from each participant was recorded and scores were given. The score for Chapman inventory scale ranged +3 to +1 while the scale ranged from 11 to 33. In case of a right leg response, the participant was given a score of 3 while in case of a left leg response a score of 1 was given. Similarly for the response of either, a score of 2 was given to each participant. Then scores were summed and based on the score obtained the participants were categorized as:

Right footed if the score ranged between 11 to 16

Left footed if the score ranged between 28 to 33

Ambidextrous if the score ranged between 17 to 27

#### **Assessment of Eye dominance**

Eyedness was assessed by using Miles test [13]. In this test the participants were instructed to stretch the arms in front of body and to place both the hands together so that a small triangle is made between the first knuckle and thumbs. A small object such as a ball was placed at a distance 6 meters and the participants were asked to look and focus on the object through the triangle with both eyes open. After that participants were asked to close left eye. If the participant was able to view the object, the right eye was considered dominant. If the hands moved of objects and moved to the left eye was considered dominant

#### **Assessment of Hair Whorl**

The hair whorl direction was categorized as clockwise and counter clockwise. It was determined via an observation on the scalp of a participant.

Statistical analysis was done using chi square test. The p value of less than 0.05 was considered statistically significant at 95% confidence of interval.

#### **Results and Discussion**

**Table 1: Relationship between hand and foot preference among left handed and right handed individuals**

Footedness	Handedness						$\chi^2$	Df	p
	Right	%	Left	%	Total	%			
Right	214	71.3	107	35.7	321	53.5	76.7	1	<0.001
Left	86	28.7	193	64.3	279	46.5			
Total	300	100	300	100	600	100			

In this table it is observed that the ipsilateral foot preference is 71.4% in right handers and 64.3% in left hander's whereas the contra lateral preferences was 28.8% and 35.7% respectively. The association between handedness and foot preference was statistically significant.

**Table 2: Relationship between hand and eye preference among left handed and right handed individuals**

Eyedness	Handedness						$\chi^2$	Df	p
	Right	%	Left	%	Total	%			
Right	229	76.3	106	35.3	394	65.7	102.25	1	<0.001
Left	71	23.7	194	64.7	206	34.3			
Total	300	100	300	100	600	100			

Table 2 shows that the ipsilateral eye preference is 76.3% in right handers and 64.7% in left handers whereas the contralateral preferences were respectively 23.7% and 35.3%. The association between handedness and eye preference was statistically significant.

**Table 3: Relationship between hand and hair whorl direction among left handed and right handed individuals**

Hair whorl	Handedness						$\chi^2$	Df	p
	Right	%	Left	%	Total	%			
Clock	207	69.5	197	65.2	404	53.5	1.221	1	0.269
Anticlock	91	30.5	105	34.8	196	46.5			
Total	298	302	300	100	600				

From the above table 3 it is found that the 69.5% of right handers and 65.2% of left handers have clockwise hair whorl whereas 30.5% and 34.8% respectively have anticlockwise hair whorl. The association between handedness and hair whorl direction was statistically insignificant.

Since inconsistent persons show more variable hemispheric specialization pronounced function, asymmetries can be observed only in more lateralized persons. Coordinated movement and fine motor control happens due to consistent lateral preferences [14]. Studies have shown that individuals preferring right hand and right foot perform better compared to those preferring right hand and left foot. Similar the case with left hand but regarding foot preference mixed pattern was seen [15].

According to Kang and Harris et al the foot preference rate in right handed individuals are 88.8% for right foot, 8.4% for left foot and 2.7% both feet, whereas in left handed individuals, it was 37.1% for right foot and

62.9% for left foot. They also stated that 100% of the ambidextrous participants showed left foot preference [16]. Cetkin M et al, in their study showed that 77.3% of right handers had clockwise hair whorl while 22.6% had a anti-clockwise hair whorl. Similarly, it was 62.5% and 37.5% respectively for left handers [17]. As per Amar J.S. Klar 8.4% of right handed individuals and 5% of left handed individuals name anticlockwise hair whorl. He suggested that a single gene may be responsible for handedness and hair whorl direction [18].

Study of Syuichi O *et al* showed ipsilateral correlation between hand and foot performances. Left hander females hand 20% tendency to use right foot while right footed females exhibited 98.8% tendency to use right hand. However regarding left hand-left foot preferences, the tendency was 100% in case of females. Similarly in case of males, left handed males showed 50% possibility of using right foot. Similar observation was reported in case of left foot-right

hand preferences. The correlation of hand and foot preference in both males and females was significant. It has also been suggested that left handed individuals confer strong association between visual and auditory processing asymmetries compared to right handers [19].

Similarly, Singh M also reported gender based difference for handedness, footedness, and relative hand skill. They showed high right preferences rates and high degree of lateralization in case of females. As per them the degree of hand skill asymmetry is proportional to age [20].

### Conclusion

Handedness is the mostly preferred marker of the cerebral lateralization, thus in this study the association of handedness with respect to foot and eye preference as well as hair whorl direction was determined. Significant association was found in between handedness, footedness and eyedness but not in case of hair whorl direction. The result of this study indicates that both foot and eye are the evident markers of functional laterality while hair whorl direction is not.

Also limbs such as hand and foot are concerned with motor function while since organs like eye concerned with sensory functions that collect information from external environment and harmonize it with the motor function of limbs, therefore understanding association between motor and sensory domains on same group of individuals using several behavioral and cognitive tasks may help in intellectual as well as social development of an individual. Most importantly it should also be noted that the social, cultural and ethnic factors may also influence the degree of hand, foot and eye preference among different communities. The present study gives the insight of such preferences in an Indian sample.

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