Research Article

Familial Trends in Handedness: A study of 30 left handed individuals and their family members

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Abstract

Left handedness is seen only in 8-15% of human population but precise cause of it is not known. According to some studies it is inherited while others report no familial correlation. Therefore the present study has been conducted on left handed subjects with the aim to trace the familial correlation of their handedness and if possible to find out genetic basis for left handedness. Present study is a trace back study which was conducted on 30 left handed primary subjects and their family members were considered secondary subjects. Handedness was evaluated using 13 items given by Raczkowski. In 16.7% families left handedness could be traced back to 2-3 more generations. Frank Left handedness was found to be running among 50% (15/30) of the families while among rest 15 families, 60% (9/15) families had one of the parents either ambidextrous or forced right handed. Left, ambidextrous or forced right handedness was more prevalent in mothers as compared to fathers (p = 0.05) and families with affected single parent are significantly higher in comparison to families with both affected parents (p>0.001). On tracing in families, it was observed that both parents were equally transmitting left handedness or ambidexterity to male as well as female offsprings Hence it is concluded that left handedness has strong hereditary correlation, Inheritance is more prevalent in families where both parents are left handed, also has correlation with maternal left handedness and inheritance is X-linked but with autosomal pattern of inheritance.

Keywords: Left Handedness, Ambidextrous, Familial, handedness

1. Introduction

Handedness has been studied for more than 160 years we still can’t precisely describe why human population is biased toward right hand1. Only 8-15% human population of the world display left handedness2. Handedness is regarded as continuum ranging from strong right handedness across mixed handedness to strong left handedness3. Various studies have reported that handedness show no or very weak parent offspring correlation4,5. Coren and Halpern6 also found no concordance in left or right handedness among monozygotic or dizygotic twins thus reported no genetic association of handedness. However certain researchers assume that handedness has hereditary correlation7. Handedness among adopted children has not shown any relationship with their adoptive parents thus suggesting a genetic control on handedness8. Thus various genetic models were suggested but each model had its own limitations in explaining different aspects of inheritance in handedness4,9 Therefore the present study has been conducted on left handed subjects with the aim to trace the familial correlation of their handedness and if possible to find out genetic basis for left handedness.
2. Material and Method

Present study is a trace back study which was conducted on 30 left handed primary subjects and their grandparents, parents, uncles, aunts (maternal and paternal), siblings and children of siblings and primary subjects were considered as secondary subjects. The persons with congenital anomaly or trauma of hands were excluded from the study. Handedness was evaluated using 13 items given by Raczkowski et al. This questionnaire has high reliability, in terms of internal consistency and high test-retest reliability. The subject were observed for the hand used for following activities: draw, write, use a bottle opener, throw, use a hammer, use a toothbrush, use a screw driver, use an eraser on paper, use a tennis racket, use a scissors, stir a can of cold drink, hold a matchstick when striking it, to indicate on which shoulder they would rest a bat before swinging. Each response was scored as: 1 for right, 2 for either, 3 for left. Total score was calculated and handedness was classified according to the score as follows: Right handed: 13-17, Ambidextrous: 18-32, Left Handed: 33-39. History of change of handedness in childhood was taken from all right handed and ambidextrous subjects. All the data was compiled and computed. Data analysis was done, mean of quantitative variables with two standard deviations calculated and student t test and chi square test was applied wherever required.

3. Observations

On tracing left handedness in the families of primary subjects, left and ambidextrous or forced right handedness was more prevalent up to two generations (Figure 1).

In five (16.7%) families left handedness could be traced back to 2-3 more generations i.e. either of the parents, uncles/ aunts, either of the grandparents and children of siblings and of the primary subject. In one family paternal grandfather, father, paternal uncles and nephew & niece of the primary subject were left handed while paternal grandmother and father were left handed in other family. In third family left handedness could be traced back to maternal grandmother, parents, all maternal uncles and aunts and paternal uncle of the primary subject while in two families grand uncles (paternal and maternal in each) were affected. Frank Left handedness was found to be running among 50% (15/30) of the families while among rest 15 families, 60% (9/15) families had one of the parents either ambidextrous or forced right handed. Left, ambidextrous or forced right handedness was more prevalent in mothers as compared to fathers (p = 0.05) and families with affected single parent are significantly higher in comparison to families with both affected parents (p>0.001)
Among families with frank left handedness, in 46.7% (7/15) families, left handedness was observed only among mothers while 33.3% (5/15) families had left handedness only in fathers but this difference is not significant (p = 0.4). Left handedness in both parents was seen only in 20% (3/15) families. Families with affected single parent were significantly higher (p=0.003). On comparison of left handed offsprings in various types of families it was observed that left handedness was more prevalent in offsprings where both parents were left handed, however the difference when compared with offsprings of single parent was not found significant (Figure 3.)

4. Discussion

Present study is representing hereditary patterns of left handedness when traced back from primary subject. In 3.33% families, left handedness was running in four generations and in 13.3% left handedness was running in three generations (Figure 1). Although the frank left handedness was seen in 50% families, however in families where only primary subjects were left handed, 60% had ambidextrous handedness in either of the parents. People are considered ambidextrous who were originally left handed and who learned to be ambidextrous, either deliberately or during childhood institutions such as schools or jobs where right-handed habits are often emphasized or required\textsuperscript{12}. This means that left handedness was actually running in 80% families but 30% were either ambidextrous or forced to use right hand. Left handedness was more prevalent in offsprings of left handed or ambidextrous parents (70.45%) and it was more so in offsprings where both the parents were left handed (Figure 3). Various studies have reported similar observations\textsuperscript{13-16}. 
Table 1: Comparison of percentage of left handed offsprings in present study with various studies

| Studies       | Year | Percentage of left handed offsprings |
|---------------|------|---------------------------------------|
|               |      | Family Type I | Family Type II | Family Type III |
| Ramaley13     | 1913 | 85.72%        | 32.35%         | 12.17%         |
| Chamberlain14 | 1928 | 28%           | 11.42%         | 4.24%          |
| Rife15        | 1940 | 54%           | 19.54%         | 7.57%          |
| Present study | 2012 | 87.5%         | 69.4%          | 70%            |

Type I- Both parents left handed, Type II- One parent left handed, Type III – Both parents right handed

Left handedness was observed among grandparents of the primary subject only in 3 families. The prevalence of left handedness among offsprings in various groups did not show significant difference (Figure 3). This was probably due to the fact that we had taken left handed persons as primary subjects and therefore we cannot comment about the prevalence of left handedness among offsprings.

We have observed a close association of left handedness in primary subjects with left handed or ambidextrous mothers (46.7%) in comparison to left handed fathers (23.3%) and this difference was significant. Mc Manus\textsuperscript{17} also observed that left handedness was more common in males but left handed mothers had more left handed offspring than left handed fathers. Various genetic models could not also explain the maternal effect on left handedness\textsuperscript{7,9}. Our findings suggest a strong genetic association of left handedness on tracing back in the families. Since left handedness was more prevalent in mothers hence suggesting X linked dominant inheritance and Corballis\textsuperscript{17} has also proposed that mutation produced a dextral allele responsible for right handedness with an additive effect while Jones and Martin\textsuperscript{18} proposed that handedness genes may be located on X chromosome and left handedness is recessive trait with low penetrance. On tracing family tree in present study, however it was observed that both parents were equally transmitting left handedness or ambidexterity to male as well as female offsprings therefore suggesting autosomal pattern of inheritance (Figure 4). Thus the data suggests that character of left handedness is X linked but inherited in autosomal pattern.

Figure 4. Showing family tree of families with: a. left handed parents, b. left handed father, c. left handed mother, d. ambidextrous or forced right handed father or mother, e. right handed parents
Mc Mannus has suggested exploring pseudoautosomal region of X chromosome to find out the genes for left handedness. The X- and Y-chromosomes contain regions of sequence identity at the ends of their respective short and long arms. The pattern of inheritance observed for alleles in the X–Y identical regions is referred to as pseudoautosomal inheritance, because it resembles the pattern seen for alleles located on autosomes. The areas of sequence identity on the X and Y are thus referred to as the pseudoautosomal regions. This probably can explain X linked but autosomal pattern of inheritance of left handedness, however further detailed studies are needed to explore and locate the gene for handedness on pseudoautosomal region of X chromosome.

Hence it is concluded that left handedness has strong hereditary correlation, Inheritance is more prevalent in families where both parents are left handed, also has correlation with maternal left handedness and inheritance is X-linked but with autosomal pattern of inheritance..

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