CHAPTER - V

SUMMARY & CONCLUSION
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There is a prevalent but mistaken notion that dermatoglyphics have no importance beyond their use in personal identification. But the pattern or epidermal ridges on fingers, palms and soles have a broader and more fundamental significance. The study of dermatoglyphics has fascinated researchers since the first work done by Purkinje in 1823. The characteristic features of epidermal ridges are:

- Dermatoglyphic pattern remains unchanged throughout the life of an individual.

- Both the nervous system and the skin have a common origin from the ectoderm in the embryo, so that any upset during this period will be reflected on nervous system and epidermal ridges.

- Development of the epidermal ridges is under genetic control, but is influenced by environmental factors.

The dermatoglyphic features are genetically determined, develop in utero, and modified by disturbances at the time of development. The dermatoglyphic features persist throughout life and
hence a reasonable assessment of the disturbances in utero can be made from the alteration in dermatoglyphic features from normal.

Alteration of dermatoglyphic patterns have been reported in several congenital conditions. A genetic disease which was first noticed because of several dermatoglyphic peculiarities was the Down syndrome. In 1939, long before the chromosomal basis of Down syndrome was established, Cummins pointed out characteristics differences in dermatoglyphic features in patients with Down syndrome compared to the normal population. These original findings have since been confirmed by many investigators, even in patients of different racial and ethnic stock, and additional dermatoglyphic anomalies have been identified. The association of abnormal ridge patterns with chromosomal aberrations has been reported by many investigators. These include aneuploidy, structural changes of chromosomes like deletions, duplications etc. Several dermatoglyphic anomalies have been observed in these studies.

As dermatoglyphic studies went on, it was noticed that in several other conditions that have a strong hereditary basis also, the dermatoglyphics is different from normal. A good example is Schizophrenia. Schizophrenia is a serious psychiatric disorder that has
a genetic basis, but this does not rule out the possibility of genetic heterogeneity and environmental risk factors. A number of studies on Schizophrenia have investigated possible environmental influences during prenatal development. As anomalies of dermatoglyphic traits were observed in persons with schizophrenia, the focus shifted to monozygotic twins with and without schizophrenia. Monozygotic twins share all their genes, whereas di-zygotic discordant twins share an average 50% of their genes, just like ordinary siblings do. However, both monozygotic and di-zygotic twins share much of the pre- and postnatal circumstances to the same degree. The dermatoglyphic analysis indicated that it could be useful in differentiating twins with a high susceptibility to schizophrenia from those with a low susceptibility to schizophrenia (van Oel, 2001).

Dermatoglyphic studies are used to detect certain multifactorial disorders. Prominent study among this is about Diabetes mellitus. Mandasescu et al (2004) used palmar prints to detect pre-diabetics. Palmar abnormalities in diabetics have been reported earlier, but the study by Mandasescu et al. was the first full scale computer study of the problem. Dermatoglyphic study thus can be a low-cost tool to detect this multi-factorial disorder at an earlier age. This is important because Diabetes mellitus has become the foremost killer
among other diseases today. Dermatoglyphic anomalies have been
reported in several other diseases like epilepsy, congenital heart
defects, hypertension, cancer, bipolar disorder, etc.

Symmetry of paired structure is an indication of
developmental stability. When developmental stability is lost, either
due to mutation or chromosomal changes or environmental factors,
FA increases. Thus FA is an indicator of developmental stability. FA
can be measured by several traits like dermatoglyphics,
odontometrics, length of bones etc. Among these, dermatoglyphic
traits are the best signs to measure developmental stability. This is
because the time during which dermatoglyphic traits are formed is
limited and once it is formed no further change occurs as one grows.

The present investigation was about dermatoglyphic of
various disability groups. The disability groups selected were children
with autism, Cerebral palsy, Down syndrome, those with learning
disability and deaf and dumb.

**Need and significance**

1. Dermatoglyphics is an important aspect of human character. The
phenotype of an organism is produced by the co-ordinated
expression of all the genes carried by the organism within the
restrictions imposed by the environment. Along with genotype, phenotypic studies like dermatoglyphics are also essential.

2. Dermatoglyphics is important in population studies. The high variability of dermal configurations makes them useful in personal identification, studies of heredity, racial variation and other biological aspects of dermatoglyphics. It is also important in Anthropology and Medicine.

3. Dermatoglyphic patterns are used in personal identification. The system of finger print identification started in India in 1897. Further development in this field occurred in other countries. The importance of finger prints in identification purposes is used in banks and high security areas. Progress in this field will replace ATM cards with identification by finger pattern in the near future.

4. Dermatoglyphic studies have been mainly reported from outside India. Even with respect to Down syndrome, several studies are available, but from India only a few studies have been reported. The study reported from Kerala is nil. Hence the relevance of the present study.
5. The dermatoglyphic study of various disability groups have not been reported so far. The present study is thus relevant in this aspect also.

6. If dermatoglyphic anomalies are present in the various disability groups, it can be used to predict the occurrence of such conditions. This is especially true of disabilities like autism and learning disability. These conditions are detected only later in life when the child does not attain developmental milestones at proper time. Early detection can lead to better management of the condition.

7. Fluctuating asymmetry of dermatoglyphic traits is a measure of developmental stability. Environmental pollutants are increasing day by day, low birth weight and pre-term infants are also on the increase, according to recent studies. The advances in medical facilities have decreased the death rate. At the same time natural selection is not operating. So there is a chance of the present generation having less developmental stability. The decrease of developmental stability can result in the occurrence of several multi-factorial disorders. So a study of dermatoglyphic traits and symmetry can give an indications of the present day health status of the present generation.
8. Dermatoglyphic provide an indirect measure of neurodevelopmental disturbances. The dermatoglyphic anomalies are indications of ‘insults’ during the embryonic period. At present no information is available regarding environmental factors affecting the embryo. The study of dermatoglyphic parameters can be correlated to a time specific ‘insult’ or ‘stress’ that had affected the embryo. More studies like this can possibly give valuable information about different stressors that may affect embryo.

For all these reasons the investigator made the study of dermatoglyphic in the five disability groups.

**Objectives of the Study**

1. To study dermatoglyphics of fingers and palms and to use it as a tool to screen the population for the pre-disposition of certain congenital disorders.

2. To study the configuration of ridges in persons coming under various categories of disability.

3. To study whether there is any significant difference in finger and palmar dermatoglyphics of persons belonging to various categories of disability.
4. To study whether a specific type of congenital anomaly in a disability group shows a significant pattern in finger and palmar dermatoglyphics, when compared to control.

5. To study whether the occurrence of Down syndrome is associated with an increase in maternal age.

Hypothesis

➢ There will be significant difference between males and females with respect to dermatoglyphics.

➢ There will be significant difference between children with autism and control group with respect to finger patterns and palmar patterns.

➢ There will be significant difference between children with Cerebral palsy and control group with respect to finger and palmar patterns.

➢ There will be significant difference between deaf and dumb children and control group in finger and palmar patterns.

➢ There will be significant difference between children with Down syndrome and control group children in finger and palmar patterns.
There will be significant difference between children with learning disability and control group with respect to finger and palmar patterns.

Congenital anomalies are reflected in the finger and palmar patterns of various disability groups.

Sample

Sample consisted of individuals affected by different disabilities. The groups included were children with autism, children with Cerebral palsy, children with deafness and dumbness, children with Down syndrome and with learning disability. The finger prints and palm prints of both hands were collected. Since comparison between left and right hand was also made, any sample without full prints was excluded from the study. The control group included graduate and post graduate students from various colleges who had no genetic disease.

Tools

Tools include printers ink, glass slab, roller etc. for taking finger prints. A magnifying glass with 10x magnification was used for identification of patterns on fingers and palms and for counting of ridges.
Method

The method for taking finger prints was that of Saha. Using printer's ink a thin film of the ink was spread on glass slab and using this rolled impressions of finger of all 10 digits were taken. Using the rubber roller, a thin film of ink was spread on the palms and the palm print was obtained.

Using a magnifying glass the prints were analysed both qualitatively and quantitatively.

The quantitative parameters included different patterns like ulnar loop, radial loop, whorl and arch on fingers, inter digital patterns present on the palm, C-line termination, palmar creases like Simian crease and Sydney line on palm, the position of axial tri-radius and ridge dissociation. Qualitative parameters included were mainly the finger ridge count of left 5 fingers, right 5 fingers, total finger ridge count, absolute finger ridge count, pattern intensity index, the atd angle, the a–b ridge count the a–b ridge difference between the left and right palm and the symmetry of patterns on homologous fingers.
The peculiarities of dermatoglyphic study are the following:

- It is cheap
- It is non invasive
- No additional equipment is required
- No laboratory facilities are needed
- A gentle effective way to work with infants, physically and mentally handicapped.
- No two people have exactly the same finger prints, not even twins.

**Statistical Analysis**

Chi-squared test was conducted for comparing the frequency of dermatoglyphics patterns between the disability groups and the control groups. Students t-test was employed for comparisons of quantitative measurements. Different dermatoglyphic parameters were analyzed using analysis of variance, (ANOVA) to compare different disability groups. Two parameters, namely a-b ridge difference between the left and right hand and the symmetry of pattern between homologous fingers were used to measure fluctuating asymmetry. The fluctuating asymmetry was expressed using Odds ratios.
RESULTS

All dermatoglyphic features were analyzed separately for males and females. The results of the study are the following in each disability group.

Autism

- Presence of more arch pattern
- Radial type C-line termination
- Abnormal palmar flexion creases
- Axial tri-radius at distal position
- Ridge dissociation
- More asymmetry of finger patterns
- a-b Ridge count difference

Findings

Presence of more arch pattern and high asymmetry of finger pattern on homologous fingers indicates an insult that has occurred early in pre-natal life. The insult can be genetic or environmental.

The abnormal palmar flexion creases, distal position of axial tri-radius, ridge dissociation etc. indicate an upset during early embryonic period. These dermatoglyphic abnormalities are not present
in all autistic children. But the dermatoglyphic anomalies are an indirect measure of upsets during embryonic period.

**Cerebral palsy**

- Increase of ulnar loops on first finger
- More patterns in the third inter digital area
- Ridge dissociation
- Low pattern intensity index
- High a–b ridge count difference

**Findings**

Finger tip patterns of children with Cerebral palsy are not different from that of control group. But differences like ridge dissociation and a–b ridge count difference are present in Cerebral palsy cases. This agrees with the hypothesis that the dermatoglyphics of persons with Cerebral palsy are different from the control group.

**Deaf and Dumb**

- Increase of whorl pattern
- Typical simian crease and Sydney line absent in male deaf and dumb group.
- Distal position of axial tri-radius
- a–b Ridge count difference is high
- Asymmetry of pattern on homologous fingers.
Findings

Dermatoglyphic features of deaf and dumb children are more similar to control group. Increase in whorls suggests an infection in the early first trimester. This may be rubella or viral fever. The infection might have caused the asymmetry in finger patterns and high a–b ridge difference. Distal position of axial tri-radius also suggests some upset during embryonic period.

Down syndrome

Several dermatoglyphic anomalies were observed in individuals with Down syndrome.

• Increase in ulnar loops
• Radial loops which are normally present on the second finger have shifted to other fingers
• Change in shape of the ulnar loop
• The C-line termination are mainly ulnar type
• Increase in abnormal palmar flexion creases
• Dissociation of ridges
• Increase in ‘atd’ angle
• Increase in a–b ridge difference
Findings

The extra chromosome in Down syndrome upsets the entire developmental pathway. This results in an upset in the genetic balance resulting in more fluctuating asymmetry. All dermatoglyphic anomalies observed in Down syndrome is related to the extra load of one chromosome. So there is ridge dissociation, high axial tri-radius, abnormal palmar flexion creases and a-b ridge difference. The study is in agreement with the hypothesis that the dermatoglyphics of Down syndrome is different when compared to control group.

Learning disability

The dermatoglyphic study of learning disabled children showed some differences from the control group.

- More whorl patterns
- Radial loops have shifted from its position on the second finger to the other fingers
- More inter digital patterns are present on the third and fourth inter digital area
- Abnormal palmar flexion creases are present
- Low ridge dissociation
- Distal axial tri-radius
- High TFRC, AFRC and 'atd' angle
- a-b ridge difference is high.

Findings

The presence of more whorl pattern indicates an infection in the early period of development. The presence of radial loops on other fingers (except second finger) also indicates some change in pattern of growth of the embryo. Abnormal palmar flexion creases and distal axial tri-radius indicates upsets during the early period. The low ridge dissociation supports the hypothesis that some upset during the first few weeks of pregnancy resulted in dissociation of ridges.

The high TFRC and AFRC are a result of increased presence of whorls. The high ‘atd’ angle is due to the position of distal axial tri-radius. The a-b ridge difference and symmetry of finger patterns in learning disabled children indicates more fluctuating asymmetry. All dermatoglyphic features of learning disabled children indicate an upset that might have happened in the early intra-uterine period. This is in agreement with the hypothesis that dermatoglyphics of children with Learning disability are different from control group. The present study agrees with the hypothesis that the dermatoglyphics of learning disabled children is different from the control group.
ANOVA performed between the five disability groups and the control group showed significant difference. So post-hoc test (Tukey's HSD method) was also used to study the difference. The findings of the study are:

- The dermatoglyphics of the disability groups are different from those of the control group.

- These differences are mostly predominant in children with Down syndrome. By looking at the hand print alone, one can identify Down syndrome.

- The differences are also present in autistic children as well as those with learning disability, Cerebral palsy and Deaf and Dumb. These differences are subtle ones. Overlapping of certain dermatoglyphic characters occur so that going by hand prints alone, one cannot identify the disability.

Odds ratio was used for two dermatoglyphic characters – finger tip pattern asymmetry and a-b ridge count difference. A fingerprint concordance < 3 was observed in all the disabled groups, but not in control group. The probability of a child to develop autism, with a fingerprint concordance below 3, is 6 times and in learning disabled group it is 4 times. The chance is only twice in children with Cerebral palsy and Deaf - mutism. It is not possible to predict Down syndrome
with finger pattern concordance, as ulnar loops (pattern of one type) is predominant in Down syndrome. An asymmetry of a difference of 4 a–b ridges or above between the left and the right palm could predict, again by Odds ratio, the chances of developing the disabilities. The chances were more in children with autism, learning disability and Down syndrome. It was less in children with Cerebral palsy and deaf mutism.

The asymmetry of finger pattern between homologous fingers and a–b ridge asymmetry indicated increased fluctuating asymmetry. So the fluctuating asymmetry increased when disorders like autism, LD and Down syndrome occurred. The FA was comparatively low in CP cases and DD group. The reason might be that both prenatal and postnatal factors cause CP and deaf–mutism.

The increased FA in the disabled groups indicated an insult that might have occurred in the 10\textsuperscript{th} to 17\textsuperscript{th} week of gestation. This is the time period in which the dermatoglyphic characters are formed in the foetus. Both the nervous system and skin develop from the same ectoderm in the embryo. So any change in the course of development of nervous system will be reflected in hand print also.
Multi-factorial diseases are caused by both genetic and environmental factors. When the environmental factors influence the developmental program, fluctuating asymmetry occurs. The Fluctuating asymmetry (FA) showed an increase in all the disability groups in the present investigation. The degree of FA varied, it was more for autism and less for CP.

Fluctuating asymmetry can be used in clinical medicine to identify predisposition to multi-factorial disorders.

**Implications**

- Dermatoglyphics may in future become the primary means of assessing complex genetic traits.

- Because fingerprints and palmar creases form during vital stages of foetal development, dermatoglyphic studies are in a unique position to evaluate the effect of toxins on the intrauterine environment (over 20% of all pregnancies never come to term).

- Dermatoglyphics are still useful for the evaluation of children with suspected genetic disorders and diseases with long latency, slow progression and late onset.

- Dermatoglyphics can be used to detect multi-factorial disorders
Limitations of the study

- Small sample size
- Incomplete diagnosis
- Limited number of variables for study
- No standard for evaluation of palmar creases and ridge dissociation

The advancement in the field of computer software and scanner technology may build up new technologies in Dermatoglyphic research in the near future. When this happens, the results may prove to be quite fascinating.