Relationship between Dermatoglyphics (finger print patterns) and breast cancer: A prospective, clinical study

Running Title: Dermatoglyphics and breast cancer

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ABSTRACT

Background
Genetic basis of breast cancer (BC) is a well-established fact. During early development, fingerprint patterns (dermatoglyphics) also develop under genetic control and remains same throughout life. Consequently, these patterns could be used as anatomical marker (non-invasive) for BC risk.
Objective
To study any relationship that exist between BC and finger print (dermatoglyphics)patterns.
Methodology
Two hundred females, aged 26-60 years were divided into cases (100 patients with BC) and control (100 patients with no BC) groups in this clinical study. Dermatoglyphic procedure followed by qualitative [whorls, arches, loops (radial, ulnar, total); I_1 to I_5 pattern] and quantitative [triradial count, a-b ridge count, atd angle, absolute finger ridge count (AFRC), total finger ridge count (TFRC), 'c' line termination] analysis of finger print patterns was performed. Statistical analysis was performed by using R software (Version. 3.6.0).
Results
Increasing total value of whorls while decreasing ulnar loops was noted in cases than controls (P<0.001). More TFRC and AFRC were noted in cases than controls (P<0.001). A significant difference was noted in the distribution of 'atd' angles, 'ab' ridge count over the groups for left hand and for both hands (P < 0.05). The inter digital patterns (I_2, I_4) showed more frequency in right hand of cases than controls (P< 0.001). The'c' line termination towards '7' was less in right and left hands of cases than controls (P< 0.001). A significant difference was noted in the triradii count in the right hand of cases and controls (P<0.001) with '5' as the maximum triradii count.

Conclusion
Qualitative and quantitative analysis of dermatoglyphic patterns can be effectively used as an adjunct to the already existing screening tools for BC.
Key words: Dermatoglyphics, Female, Fingers, Finger ridge count
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INTRODUCTION

Breast cancer constituting around one-third of women malignancies and is the most common women cancer. Among all cancer deaths it is the second highest cause after lung cancer [Olopade et al, 2008].[1]globally, breast cancer impact 2.1 million women/ year. It is estimated that from breast cancer around 627,000 women die/year, which is approximately 15% of total cancer deaths among women (DeSantis et al, 2017).[2] In India, one in twenty-eight Indian women during her lifetime is prone to develop breast cancer. It is more frequent in urban women (1/ 22) than the rural women (1/ 60) (Nagrani et al, 2014).[3]

A well-established factor in the etiology of breast cancer is the genetic component and involvement of certain genes viz. BRCA1, BRCA2, p-53 etc. which have been studied extensively and are recognized as genetic link for breast cancer [Saxena et al, 2006].[4] It has further been observed that specific fingerprint patterns are associated with a family history of breast cancer [Khandelwal et al, 2007].[5]

Finger print determination or Dermatoglyphics, is genetic but is also affected by the environmental factors during first trimester in pregnancy. However, the patterns remain almost constant after birth and thus could be an essential tool in studying the genetic patterns of cancer in any individual [Raizada et al, 2013].[6]The study of dermatoglyphics plays an important role in the diagnosis of chromosomal disorders. Dermatoglyphics has played a significant role in diagnosis of Turner's syndrome, Down's syndrome, Trisomy 18 syndrome, etc. (Khandelwal et al, 2007).[5] Thus, it could be used for screening or as a guide to future research for breast cancers as the dermatoglyphic prints can represent a noninvasive anatomical marker for risk of breast cancer [Shrivastava and Bose, 2019].[7]

There is a paucity of studies determining the statistical significance of the difference found between dermatoglyphic patterns in breast cancer patients and normal individuals and relationship between breast cancer and finger print patterns (Gul et al, 2018).[8]Therefore,the present study focused on studying the relationship that exist between breast cancer and finger print patterns of breast cancer patients and normal individuals.

MATERIALS AND METHODS

Study Design

With the institutional ethics committee's approval, this hospital-based, prospective, clinical study was conducted in the Department of Anatomy at a private medical college over a period of 24 months (November 2017-November 2019). Written informed consent was obtained from all the patients included in the study.

Sample size

The formula used for sample size calculation was

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$$n = \frac{2\left(Z_{\frac{\alpha}{2}} + Z_{\beta}\right)^2}{d^2}$$

$$where, \quad d = \frac{|\mu_1 - \mu_2|}{\sigma}$$

Where, μ_1 is mean of the first group, μ_2 is mean of the second group, σ^2 is the common error variance, $Z_{\alpha/2}$value is 1.96 for 95% confidence level and Z_β value is 1.645 for 95% power.

By considering ATD angle of left hand in group 1 (Cases) and group 2 (Controls) as 41.6 ± 6.38 and 44.5 ± 4.11 respectively (from following reference), at 5% level of significance, and 95% power, the sample size is obtained to be

90 subjects per each group. Total sample size required is 90 x 2 = 180 subjects.

As sample size increases, accuracy of result increases. So, 200 samples were considered in this study (100 each).

Selection Criteria

Two hundred female subjects, aged 26-60 years were considered for the study. These subjects were further divided into two groups: 100 were in control group while remaining 100 were in cases group. Control subjects with no breast cancer neither the history of the disease in the blood relatives; and cases subjects who had confirmed histopathological breast cancer and registered for radiotherapy or chemotherapy were included in the study. Critically ill patients on life support, patients with claustrophobia and known allergy to dye agent, cancer patients other than breast cancer were exempted from the study.

Dermatoglyphics Procedure

An ink-print palmer and finger print method was used with both hands (right and left) (Cummins and Midlo, 1943).[9] Palms and fingers of all subjects were cleaned with soap and water at the first instance, and then followed by spirit to remove any sweat, oil and any other dirt. The ink was uniformly spread and the prints were taken by pressing all the areas of palms and fingers in sequence on a white thick paper sheet. In accordance with Cummin's method, the prints on the white duplicating papers were screened with the aid of magnifying glass (Cummins et al, 1929).[10]

Dermatoglyphic Analysis

The dermatoglyphic analysis was of following two types:

Qualitative analysis

This analysis involved the study of finger print patterns such as whorls, arches, loops (radial, ulnar, total); patterns in interdigital areas such as I_1 to I_5 pattern.

Quantitative analysis

This analysis involved the study of palmer patterns such as triradial count, a-b ridge count, atd angle, absolute finger ridge count (AFRC), total finger ridge count (TFRC), 'c' line termination.

Statistical Analysis

Statistical analysis was performed by using R software (Version. 3.6.0). Categorical variables are represented by frequency tables. Continuous variables are represented in Mean ± SD form. Qualitative variables were analyzed using Chi-squaretest of independence, proportion test. Quantitative variables were analyzed using Welch two-sample t test, Mann Whitney U test. Data was considered statistically significant when $P \leq 0.05$.

RESULTS

A total of 200 patients completed this prospective study. Here, in some tables of finger patterns, the pattern in 10 fingers of 100 subjects is considered. Therefore, n = 1000.

An increase in total value of whorls while a decrease in total value of ulnar loops was noted in cases than controls which was statistically highly significant ($P<0.001$). A decrease in total radial loops and arches was noted in cases than controls, however it was not statistically significant ($P>0.001$) (Table 1).

A significance difference between mean TFRC and mean AFRC was noted between case and control groups ($P<0.001$) with more TFRC and AFRC in cases than in controls (Table 2).

A significant difference was noted in the distribution of 'atd' angles over the groups for left hand ($P < 0.05$). No significant difference in distribution of 'atd' angles over the groups for right hand ($P > 0.05$). A significant difference was noted in the distribution of 'ab' ridge count over the groups for both hands ($P< 0.001$) (Table 3).

The interdigital patterns like I_2, I_4 showed more frequency in right hand of cases than controls with statistically significant difference ($P< 0.001$). The inter digital patterns like I_2, I_4 and I_5 also showed more frequency in left hand of cases than controls with statistically significant difference ($P< 0.001$) (Table 4).

The'c' line termination towards '7' is less in right and left hands of cases than controls and this difference is statistically significant ($P< 0.001$). However, the 'c' line termination towards '8' and '9' is more in right and left hands of cases than controls and this difference is statistically significant ($P< 0.001$) (Table 5).

A significant difference was noted in the triradii count in the right hand of cases and controls (*P*<0.001) with '5' to be the maximum triradii count among cases as well as controls for both hands. However, no significant difference was noted in the triradii count in left hand of both cases and controls (*P*>0.05) (Table 6).

DISCUSSION

A most cost-effective strategy of providing quality and essential health care for breast cancer patients is by developing a diagnostic method which is non-invasive. It could be helpful in identifying women who are either already have this illness or are at risk of it.[8] Such diagnostic methods are mostly important in developing and under developed countries with large and increasing populations. Dermatoglyphics analysis is one such technique (Oladipo et al, 2009).[11] Thus, the present study was carried out to find out if any relationship existed between breast cancer and dermatoglyphics (finger print patterns).

The present study showed frequent increased occurrence of whorls but decreased occurrence of loops (ulnar and radial) and arches in breast cancer patients (cases) as compared to healthy individuals (controls). This is in line with the previous literature results which indicated that breast cancer cases show high frequency of presence of whorls and less loops and arches as compared to healthy controls (Chintamani et al, 2007; Fulari et al, 2012).[12, 13] However, in contrast to our study, Sridevi et al (2010) in their study found that ulnar loops were significantly more in breast cancer patients.[14] This difference could be due to the difference in racial group and geographical area among the two studies. Further, it has been observed that more than 32% of the breast cancer patients show a usually high number i.e. six or more whorls, than normal. This has been attributed to certain genetics factors such as genetic mutations found in breast cancer patients (Singh et al, 2019).[15]

The TFRC and AFRC was noted to be more in breast cancer cases than control with a highly significant difference. This is in accordance with the study findings of Inamdar et al (2006), who reported a significant increase in the frequency of TFRC and AFRC in the cancer patients in comparison to the controls.[16] This is contrast with another study which showed no significant differences in the TFRC and the AFRC between the controls and the cancer patients (Chintamani et al, 2007).[12] This difference could be attributed to the different genetic makeup of the different study populations. All epidermal ridges such as finger ridges once laid down during gestation, remain unchanged except for an increase in size due to general human growth. The formation of these ridge patterns has some genetic influence and thus a positive correlation exists between finger ridge count and genetically based disease conditions, such as breast cancer (Shazya et al, 2018).[17]

A significant difference was noted in the distribution of 'atd' angles over the groups for left hand with low 'atd' angle in cases as compared to controls. Also, there was increased 'ab' ridge count in breast cancer cases then controls for both the hands with highly significant difference. This is in accordance with the study findings of Oladipo et al (2009) in which the 'atd' angle of women with malignant mammary neoplasm was lower than the 'atd' angle of normal subject in the left hand.[11] The 'ab' ridge count was noted to be high in breast cancer patients in comparison to control in a study conducted by Shazya et al (2018) which is in line with this study findings.[17] The 'atd' angle of hand indicates speed and degree of co-ordination between the muscular and nervous systems, thus reflecting one's efficiency. Each individual has its characteristic ridge configuration which is unique and remains unchanged from womb to tomb. This efficiency decreases under malignant conditions resulting into decreased 'atd' angle (Raizada et al, 2013).[6] Further, increased values of palmar 'ab' ridge count is taken as an indication of for some breaches in the homeostasis of the individual or a disturbance of the genetic control in the formation of papillary patterns in cases with breast cancer (Yaneva et al, 2018).[18]

The inter digital area patterns like I_2, I_4 showed more frequency in right and left hand of cases than controls and the difference was significant, in the present study. Similar findings were noted by Sridevi et al (2010), as they noted that the frequency of occurrence of I_2, I_4 and I_5 interdigital area pattern was more in cases of breast cancer patients.[14] This could be attributed to the fact that in breast cancer patients there appears decreased 'atd' angle in interdigital area, leading to the formation of specific patterns, noted only in cancer patients (Raizada et al, 2013).[6]

Further, the present study indicated that the'c' line termination towards '7' was less in right and left hands of cases as compared to controls. This is in line with the findings of study by Pahuja et al (2013), in which the main 'c' line terminations in cancer patients significantly differed from the controls, as 'c' line termination towards '7' and '9' was less in breast cancer patients.[19] This could be attributed to the genetic basis of breast cancer disease (Galina and Ingilizova, 2018).[20]

The maximum tri-radial count for both hands among cases and controls was '5' with a significant difference noted in the right hand of cases and controls. Similar findings were noted by Gul et al (2018) as in their study mean tri-radial count in breast cancer and control group showed statistically significant difference, due to increased tri-radial count in breast cancer group, i.e. 5.[8]

The present study has its own limitations. The sample size taken was small from single geographical area, which is not sufficient for generalizing the results. Further, the considered parameters were not studied in relation to the genes BRCA1 and BRCA2, in relation to intralobular and intraductal breast carcinomas. Therefore, further studies in this area are obligatory with larger sample size in different geographical areas and population groups with relation to the intraductal, intralobular breast carcinomas and further in relation to the BRCA1 gene and BRCA2 gene for understanding the relevance in using dermatoglyphic study (as a screening procedure).

CONCLUSION

The present study concludes that an increase in total value of whorls while a decrease in total value of ulnar loops, decrease in total radial loops and arches; more TFRC and AFRC; decreased 'atd' angle but increased 'ab' ridge count; more frequency of I_2, I_4 (inter digital patterns) in right hand, among breast cancer cases is strongly associated with carcinoma breast. Therefore, qualitative and quantitative analysis of dermatoglyphic patterns/traits, when performed effectively, could be of promising value, in being used as an adjunct to the already existing screening tools for breast cancer.

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TABLES

Table 1: Comparison of finger patterns over the groups.

Finger patterns	**Cases (n=1000) f (%)**	**Controls (n=1000) f (%)**	***P* value [P]**
Whorls	472 (47.2)	254 (25.4)	**< 0.001***
Radial loops	7 (0.7)	16 (1.6)	0.0934
Ulnar loops	297 (29.7)	397 (39.7)	**< 0.001***
Arches	101 (10.1)	118 (11.8)	0.2519

21. f (%): frequency (percentage); P: Proportion test; *: Significant

Table 2:Comparison of finger ridge counts over the groups

Patterns	**Cases (n=1000) (M± SD)**	**Controls (n=1000) (M± SD)**	***P* value**
TFRC	208.71 ± 86.12	141.85 ± 66.15	**< 0.001[wt*]**
AFRC	142.57 ± 50.55	113.93 ± 38.07	**< 0.001[t*]**

22. AFRC: absolute finger ridge count; M±SD: Mean± Standard deviation; TFRC: total finger ridge count; t: Two sample t test; wt: Welch two-sample t test; *: significant

Table 3: Comparison of 'atd' angles and 'ab' ridge count over the groups for both hands

Palmer pattern	Hand	Cases (n=100) (M± SD)	Controls (n=100) (M± SD)	*P* value ^{MW}
'atd' angles	Right	40.3 ± 3.78	41.07 ± 5.46	0.355
	Left	39.99 ± 3.88	41.78 ± 5.58	**0.0362***
'ab' ridge count	Right	39.97 ± 6.4	35.68 ± 5.29	**< 0.001***
	Left	39.4 ± 6.19	36.23 ± 4.88	**< 0.001***

23. M±SD: Mean± Standard deviation; MW– Mann Whitney U test; *: Significant

Table 4: Comparison of I_1 to I_5 patterns for both hands among the groups

Interdigital area patterns	Right		*P* value ^{P}	Left		*P* value ^{P}
	Cases (n=100) f (%)	Controls (n=100) f (%)		Cases (n=100) f (%)	Controls (n=100) f (%)	
I_1	12 (12)	14 (14)	0.8335	10 (10)	15 (15)	0.3924
I_2	22 (22)	4 (4)	**< 0.001***	31(31)	9 (9)	**< 0.001***
I_3	45 (45)	59 (59)	0.0658	46 (46)	60 (60)	0.0655
I_4	24 (24)	59 (59)	**< 0.001***	13(13)	55 (55)	**< 0.001***
I_5	23 (23)	21 (21)	0.8645	10 (10)	26 (26)	**0.0058***

24. f (%): frequency (percentage); I: Interdigital; P: Proportion test; *: Significant

Table 5: Comparison of 'c' line termination for both hands among the groups

'c' line termi-nation	Right			*P* value ^{MC}	Left			*P* value^{MC}
	Cases (n=100) f (%)	Controls (n=100) f (%)	Total (200)		Cases (n=100) f (%)	Controls (n=100) f (%)	Total (200)	
7	3 (3)	31 (31)	34 (17)	**< 0.001***	6 (6)	28 (28)	34 (17)	**< 0.001***
8	4 (4)	0	4 (2)		9 (9)	0	9 (4.5)	
9	93 (93)	69 (69)	162 (81)		85 (85)	72 (72)	157 (78.5)	

25. f (%): frequency (percentage); MC: Chi square test with Monte Carlo simulation; *: Significant

Table 6: Comparison of triradial count for both hands among the groups

Triradii count	Right			*P* value ^{MC}	Triradii count	Left			*P* value^{MC}
	Cases (n=100) f (%)	Controls (n=100) f (%)	Total (200)			Cases (n=100) f (%)	Controls (n=100) f (%)	Total (200)	
3	1 (1)	0	1 (0.5)	**< 0.001***	4	2 (2)	0	2 (1)	0.07096
4	2 (2)	0	2 (1)		5	94 (94)	88 (88)	182 (91)	
5	96 (96)	82 (82)	178 (89)		6	4 (4)	6 (6)	10 (5)	
6	1 (1)	14 (14)	15 (7.5)		7	0	4 (4)	4 (2)	
7	0	4 (4)	4 (2)		8	0	2 (2)	2 (1)	

26. f (%): frequency (percentage); MC: Chi square test with Monte Carlo simulation; *: Significant