Can Dermatoglyphics be used as an Anatomical Marker in Egyptian Rheumatoid Patients?

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Abstract: Background/aim: Rheumatoid arthritis (RA) is supposed to be influenced by genetic and environmental factors and so also dermatoglyphics. Therefore, the present study was undertaken to find out a possible correlation of some quantitative and qualitative dermatoglyphic variables with rheumatoid arthritis (RA) and its radiological grading. Materials and methods: This study was conducted on 60 clinically confirmed RA patients and an equal number of controls. Different qualitative dermatoglyphic patterns (ulnar& radial loops, whorls and arches) and quantitative dermatoglyphic measures (total finger ridge count, pattern intensity and a-b ridge count) in addition to palmar creases were studied on rheumatoid arthritis patients and controls. Comparison between patients and controls in both sexes was done and recorded. Also, correlation between significant dermatoglyphic changes in RA patients and radiological changes were studied. Results: Loops were the most common type of the qualitative dermatoglyphic patterns of the fingers, followed by whorls then arches. In both male and female patients, there was significant marked decrease in ulnar loops and significant increase in arches. Total ridge count and pattern intensity of patients were decreased in both hands of both sexes; however, this decrease was significant in the left hand of males and right hand of females. Moreover, the a-b ridge count was significantly decreased in both hands of female and left hand of male patients. Regarding the unusual palmer flexion creases, there was significant increase only in the Sydney line in female right hands. Significant inverse correlation was noted between total ridge count of the fingers and the radiological erosion in both males and females. Conclusion: The findings of the present work demonstrate the association between some dermatoglyphic patterns and RA suggesting that dermatoglyphics can represent an anatomical, non-invasive, inexpensive tool for screening high-risk population, and thus facilitate early detection and management. Also the relationship between total ridge count and the aggressive type of RA indicate that this dermatoglyphic variable might play a significant role not only for screening but also for studying the behavior of the disease.

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1. Introduction:

Rheumatoid arthritis is a chronic inflammatory disease that predominantly manifests as persistent synovial inflammation of peripheral joints. Severity and prognosis of RA are influenced by a veriety of demographic factors, such as race, gender, age, profession and educational level (Landewe, 2007).

The clinical course of Rheumatoid arthritis (RA) fluctuates and its prognosis is difficult to predict. In many patients the disease was severe resulting in progressive joint erosion, destruction and severe disability which are not capable of recovery (Dubucquoi et al., 2004). Early treatment with the currently available anti-rheumatic drugs may stop or delay such erosions. To avoid the potentially serious side effects, diagnostic tests of high specificity for RA are desirable (De Vries Bouwstra et al., 2005). The prognostic markers that could identify patients with the aggressive rapidly progressing type of the disease would help in early diagnosis and treatment. They would also protect patients with less aggressive disease from possible over treatment and toxicities (Landewe, 2007).

Dermatoglyphics came from ancient Greek derma (skin) and glyph (Carving). It is the scientific study of the pattern configurations of finger and palm prints. They have a significant genetic component and its development begins during the second month of intrauterine life. They also reflect the non genetic environment of early pregnancy, an important time window for tissue differentiation and organogenesis. Fingerprints and the number of epidermal ridges observed in postnatal life provide a measure of fingertip growth activity during the early fetal period and may be useful in the study of metabolic or anatomic programming related to the early prenatal environment. Also, the presence of abnormalities in dermatoglyphics constitutes an evidence of a prenatal insult that has occurred in early prenatal life (Zhou et al., 2002 & Kahn et al., 2008).

The finger and palmar print patterns have already been studied with respect to various genetic diseases like Down, Turner and Klinefelter syndromes (Richards and Mandasescu, 1997 & Kobyliansky et al., 1999). In one study, dermatoglyphics were used as markers of early prenatal stress in children with idiopathic intellectual disability (Rosa et al., 2001). Also, several studies have reported its alterations in gastric cancer (Zivanović et al., 2003), bronchial asthma (Gupta and Prakash, 2003), schizophrenia (Chok et al., 2005), open angle glaucoma (Novak-Laus et al., 2005) and breast cancer (Chintamani et al., 2007).

Few studies are available on the association between dermatoglyphics and RA. Both genetic and environmental factors can contribute to the susceptibility and severity of RA disease (Reveille, 1998). Since ridge patterns are formed early in fetal development and remain unchanged throughout life, unusual dermatoglyphics may indicate gene or chromosomal abnormalities consistent with a disease such as RA (Rajangam et al., 2008).

Therefore, the present study was undertaken to find out a possible correlation of some quantitative and qualitative dermatoglyphic variables with rheumatoid arthritis (RA) and its radiological grading.

2. Materials and methods

This study was carried out on 60 RA patients diagnosed according to the American College of Rheumatology (ACR) revised criteria for the classification of RA (Arnet et al., 1988). They were 12 males and 48 females and their ages ranged from 23-63 years with a mean of 41.3 ± 8.2.The duration of the disease ranged from 5 months to 10 years with a mean of 4.2±2.3 years. These patients were recruited from the attending outpatient clinic of the Physical Medicine and Rheumatology of Tanta University Hospital in addition to 60 apparently healthy persons (12 males and 48 females) that had no self or familial history of RA and served as a control group. It may be noted that, for any study on dermatoglyphics, age similarity may not be required because the dermatoglyphics, once formed usually do not change, unless affected by occupational hazards. Consent was taken from all participants and detailed clinical examination was done to exclude patients with congenital diseases, hand burn, deformity or injury.

The following parameters were obtained: different patterns of finger tips (finger prints), total finger ridge count (number of epidermal ridges), pattern intensity (total number of tri-radii of the fingers), types of palmar creases and the a-b ridge count of the palm (number of ridges between the bases of index and middle fingers). The prints of all participants were taken by the ink and paper method. The ends of the fingers were inked and then pressed or rolled one by one on a glossy paper. Also, the palm of clean dried hands were smeared with the ink and pressed against the paper to show palmar creases and the interdigital areas. The prints were then scanned and analyzed. Counting of palmar and finger ridges were done by magnification of the prints by computer or a magnifying hand lens. All parameters were studied on both hands together and separately. Comparison between patients and controls in both males and females was also done.

Dermatoglyphic Patterns:

Fingerprint patterns in the present study included three main types: whorls, loops, and arches. Under these major types, other subtypes were also noticed in the present study and considered normal anatomical variations (Figs.1, 2, 3). The whorl is distinguished by its concentric design. The majority of the ridges make circuits around the core (Fig. 1). In arches, the dermal ridges pass from one margin of the digit to the other with a gentle, distally bowed sweep (Fig. 2). In loops, the ridges curve around only one extremity of the pattern forming the head of the loop. Loops can be further divided into ulnar and radial types: ulnar loop when the loop opens to the ulnar margin of the hand and radial loop when the loop opens to the radial margin (Fig. 3).

A triradius is located at the meeting point of three opposing ridge system (Fig 4). This marks the edge of the loop pattern as it possesses only one triradius. In arch pattern, there is no triradius while whorls usually have two triradii.

Ridge Count of the fingers: After locating the triradii and the core, as the outer and inner points of the count, a line is set in position to connect them (Fig. 3). Ridge counts for each fingertip were calculated from the number of primary epidermal ridges that intersected or touched the straight line drawn from the central core of the fingerprint pattern to the bifurcation of the triradius. The count on the ten fingers of each individual is then summed up to give a single value, the total ridge count. Consistent with standard methods, fingertips with an arch pattern were assigned a ridge count of zero. Fingertips with a loop pattern have a ridge count equal to the number of ridges crossing the single straight line (Fig. 3). For fingertip patterns with two triradial points e.g., whorls, the following ridge-counting protocol was used according to Kahn et al., (2001) ridge count = ridges crossing the longer line + half of ridges crossing the shorter line (Fig. 3).

The a-b ridge count is a measure of the size of the second interdigital area of the palm of the hand, between the bases of the index and middle fingers. It is made by the count of the number of ridges between the triradius a, at the base of the index finger, and the triradius b, at the base of the middle finger (Fig. 4).

Pattern Intensity: Pattern intensity refers to the complexity of ridge configurations. It can be expressed by counting the number of triradii present. According to the number of triradii, a digit can have a pattern intensity that ranges from zero to two. Considering the two hands together, the number of triradii in all ten fingers of an individual ranges from zero to twenty. The simple arch, which lacks a triradius, is assigned the number 0, the tented arch and the loop are both assigned 1, as each has one triradius and the whorls typically possess two triradii (Figs.1,2,3).

Flexion creases: Normally there are three main flexion creases in the palm of the hand, distal transverse, proximal transverse and longitudinal. The abnormal palmer flexion creases considered in the present study were the Simian line, partial Simian line and the Sydney line (Figs. 5,6). In Simian Line, the two distal horizontal creases are fused to form a single horizontal crease. Sometimes there will be traces of the original lines which attempt to fuse as they move across the palm but instead of creating a fully formed Simian, they form what is called partial simian line. Sydney line means the continuation of the proximal transverse crease until the ulnar border of the palm. Interpretation of all parameters was done according to the previous dermatoglyphic studies of Rosa et al., (2001); Zhou et al., (2002); Ravindranath et al., (2003); Corona Rivera et al., (2005) and Karmakara et al., (2008).

Radiological assessment: Postero-anterior radiographs of the hands of the patients were obtained and the degree of RA progression was assessed according to Larsen scoring (Larsen, 1995).

Statistical Analysis:

The collected data were organized, tabulated and statistically analyzed using SPSS software statistical computer package, version 12. The differences of qualitative data of finger tips (whorls, loops and arches) and that of the quantitative data (total finger ridge count, pattern intensity and a-b ridge count) as well as palmar creases were recorded. As regards to the qualitative data, the number and percentage of distribution were calculated. For quantitative data, the range, mean and standard deviation (SD) were measured. In addition, the correlation between radiographic erosion and the significant dermatoglyphic variables detected in this study was evaluated by Pearson's correlation coefficient. The difference between two means was statistically analyzed using the student t-test and the differences were considered significant at P<0.05.

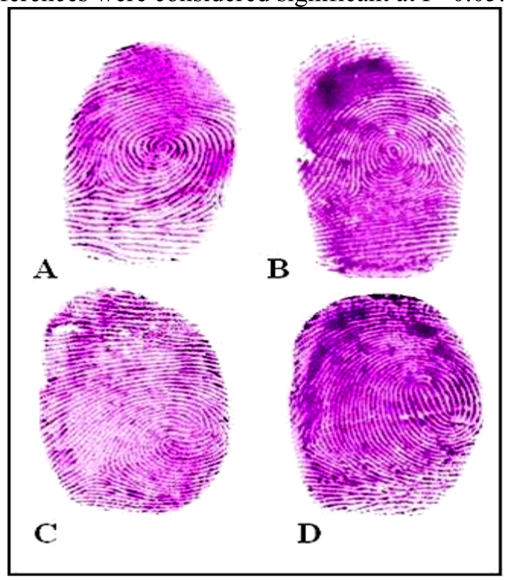

Fig. (1): A photograph showing the different types of whorls observed in the present study.
(A) Shell or snail whorl (B) plain or simple whorl
(C) Double loop whorl (D) Elongated whorl

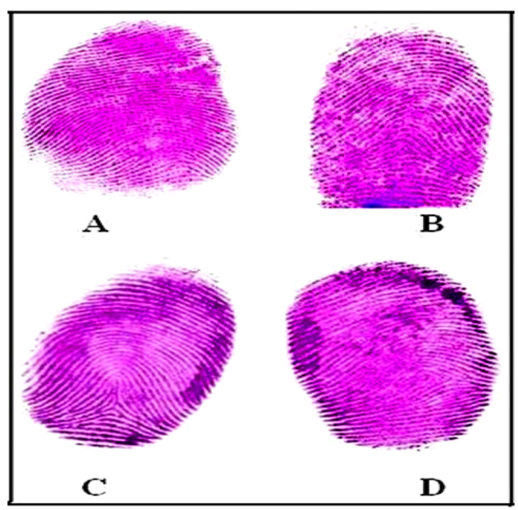

Fig. (2): A photograph showing the different types of arches observed in the present study. (A) Simple arch. (B) High arch. (C) Tented arch. (D) Arch with a loop.

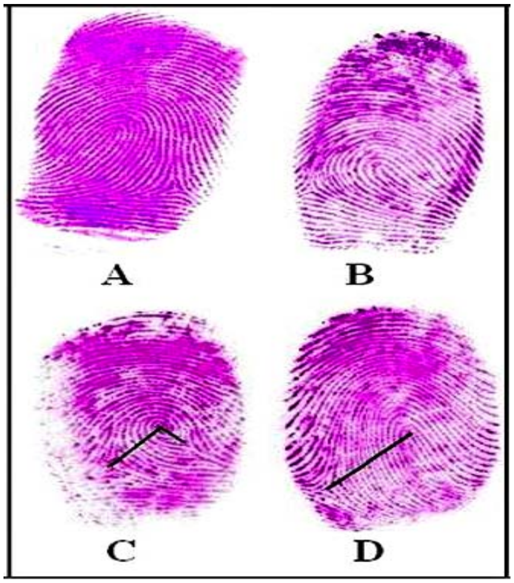

Fig. (3): A photograph showing: (A) Ulnar loop. (B) Radial loop. (C) Measurement of total ridge count in whorl pattern. Notice the long line between the core of the whorl and the triradius, and the short line between the core and the second triradius. (D) Measurement of total ridge count in a loop pattern. Notice the presence of only one line between the core of the loop and the only one triradius.

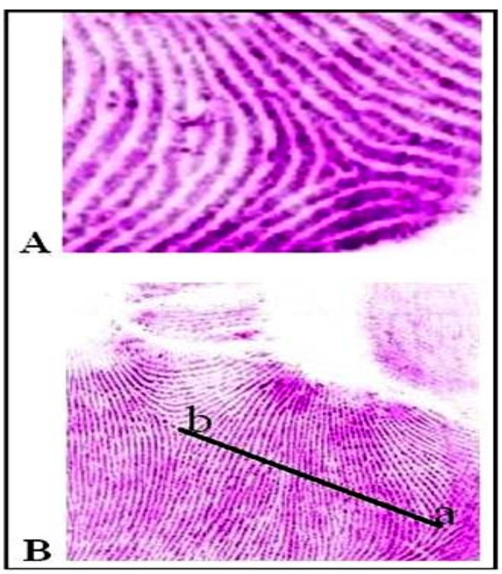

Fig. (4): A photograph showing: (A) Magnification of the triradius. (B) Measurement of a-b ridge count. Notice the line between the triradius a at the base of index finger and triradius b at the base of the middle finger.

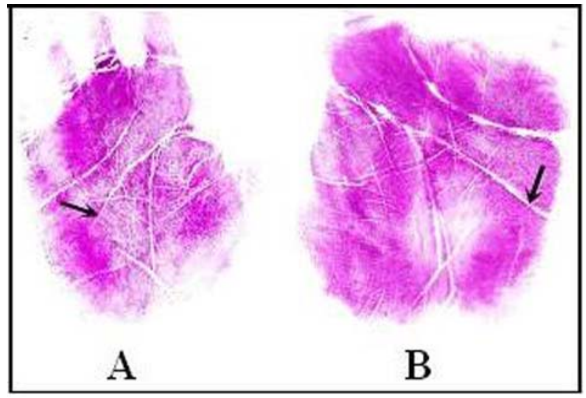

Fig. (5): A photograph showing: (A) Normal palmar flexion creases. Notice the proximal palmar crease (arrow). (B) Sydney line. Notice the continuation of the proximal palmar crease until the ulnar border of the palm (arrow).

3. Results

In the present study, loops were the most common type of finger ridge patterns, accounting for 48.5% of finger prints of normal individuals, followed by whorls (40.83%), and lastly the arches (10.67%).

The distribution of finger ridge patterns in patients and controls are shown in tables (1, 2). It was found that ulnar loops were significantly decreased in both hands of male and female patients. In males, the P value was 0.021 in right hand and 0.004 in left hand, while in females P value was 0.011 in right hand and 0.001 in left hand. The radial loops showed non significant increase in male left hand (P= 0.863) and non significant decrease in female right and left hands (P= 0.0352, 0.896) respectively. Arches were significantly increased in both right and left hands of males (P=0.009, 0.007) respectively and of females (P= 0.003, 0.028) respectively. As regards to whorls, non significant decrease was noticed in male right and left hands (P= 0.078, 0.089) respectively, while in females there was non significant decrease in right hand (P= 0.0236) and non significant increase in the left hand (P= 0.058). (Tables 1, 2).

The total ridge count of fingers is presented in table 3. The mean ridge count of the RA patients was decreased in both hands of males and females when compared to the controls.This decrease was statistically significant in the left hand of males (P= 0.002) and right hand of females (P= 0.001).

The main pattern intensity (number of triradii in finger tips) included in the present study is shown in table 4. It was decreased in RA patients in both males and females. It was statistically significant in left hand of males (P= 0.019) and in right hand of females (P= 0.012).

The a-b ridge count (number of ridges between the triradi a&b at the bases of index and middle fingers) is considered in table 5. The mean a-b ridge count of RA patients was decreased in both hands of males and females in comparison to the control. This decrease was statistically significant in left hand of males (P= 0.002) and both hands of females (P= 0.001, 0.001).

The distribution of unusual palmar flexion creases in the RA patients and controls is shown in tables 6,7. The most frequent unusual creases were Sydney line, Simian and partial Simian creases. The only significant increase was in the Sydney line in female right hands (P=0.050).

Comparison between patients with radiological erosion detected by x-ray and the significant dermatoglyphic variables observed in this study was done. Considering both hands together, significant inverse correlation was noted between total ridge count of the fingers and radiological erosion in both males and females (P=0.023, 0.039) respectively (Tables 8, 9 and figures 7,8).

Table 1: Pattern distribution on fingertips of males included in the study:

Type of pattern	Control (n=12)		RA (n=12)		P1	P2
	Right hand	Left hand	Right hand	Left hand		
Whorls	28	24	24	20	0.078	0.089
Radial Loop	2	2	2	3	0.963	0.863
Ulnar Loop	27	27	16	6	0.021*	0.004*
Arches	5	5	19	31	0.009*	0.007*

* significant P1 comparison between right hands of control and RA patients
P2 comparison between left hands of control and RA patients.

Table 2: Pattern distribution on fingertips of females included in the study:

Type of pattern	Control (n=48)		RA (n=48)		P1	P2
	Right hand	Left hand	Right hand	Left hand		
Whorls	99	94	97	102	0.236	0.058
Radial Loop	27	13	23	12	0.352	0.896
Ulnar Loop	90	103	60	51	0.011*	0.001*
Arches	20	34	63	72	0.003*	0.028*

* significant P1 comparison between right hands of the control females and RA females patients
P2 comparison between left hands of the control females and RA females patients

Table 3: Total finger ridge count of males and females included in the study:

	Control (n=60)		RA (n=60)		P1	P2
	Right hand	Left hand	Right hand	Left hand		
Males						
Range	48- 96	50-114	44-72	32-61	0.875	0.002*
Mean± SD	81.85±10.45	81.33±18.07	62.33±9.38	43.83±8.96		
Females						
Range	45-93	48-95	31-64	41-65	0.001*	0.587
Mean± SD	82.87±10.64	85.12±9.15	43.66±8.97	54.7±7.15		

* significant P1 comparison between right hands (male & female) of control and RA patients
P2 comparison between left hands (male & female)of control and RA patients.

Table 4: Main pattern intensity of males and females included in the study:

	Control (n=60)		RA(n=60)		P1	P2
	Right hand	Left hand	Right hand	Left hand		
Males: Range / Mean± SD	5-14 7±1.32	5-12 6.41±0.76	4-9 6.58±1.32	3-5 4.08±0.425	0.445	0.019*
Females: Range / Mean± SD	4-15 6.56±0.95	4-13 6.33±0.83	3-8 5.77±0.73	4-7 6.18±0.91	0.012*	0.263

* significant P1 comparison between right hands (male & female)of the control and RA patients
P2 comparison between left hands (male & female) of control and RA patients.

Table 5: a-b ridge count of males and females included in the study:

	Control (n=60)		RA(n=60)		P1	P2
	Right hand	Left hand	Right hand	Left hand		
Males Range / Mean± SD	30-42 37.66±3.98	30-45 38.75±4.33	29- 40 34.83±3.9	28-35 32±2.86	0.095	0.002*
Females Range / Mean± SD	38-50 44.66±4.33	36-47 41.2±3.38	29-36 32.77±2.46	31-40 37.68±2.56	0.001*	0.001*

* significant P1 comparison between right hands(male & female) of control and RA patients
P2 comparison between left hands(male & female) of control and RA patients.

Table 6: Unusual palmar creases of males included in the study:

Patterns of palmar creases	Control (n=12)		RA (n=12)		P1	P2
	Right hand	Left hand	Right hand	Left hand		
Partial simian	1	0	1	1	0.963	-
Complete simian	0	1	1	1	-	0.963
Sydney line	1	0	2	0	0.756	-

* significant P1 comparison between right hands of controls and RA patients
P2 comparison between left hands of controls and RA patients.

Table 7: Unusual palmar creases of females included in the study:

Patterns of palmar creases	Control (n=48)		RA (n=48)		P1	P2
	Right hand	Left hand	Right hand	Left hand		
Partial simian	1	0	1	1	0.963	-
Complete simian	0	0	1	0	-	-
Sydney line	1	2	3	2	0.050*	0.865

* significant P1 comparison between right hands of the female controls and RA female patients
P2 comparison between left hands of the female controls and RA female patients

Table 8: Pearson's correlation coefficient between RA male patients with radiological erosion and significant dermatoglyphic variables.

Variable	Radiological erosion	
	R	p
Ulnar Loop	-0.167	0.219
Arches	-0.042	0.243
Total finger ridge count mean	-0.584	0.023*
a-b ridge count mean	-0.144	0.343
Pattern intensity mean	0.104	0.619

Table 9: Pearson's correlation coefficient between RA female patients with radiological erosion and significant dermatoglyphic variables.

Variable	Radiological erosion	
	R	p
Ulnar Loop	-0.132	0.668
Arches	-0.128	0.677
Total finger ridge count mean	-0.661	0.039*
a-b ridge count mean	-0.007	0.983
Pattern intensity mean	-0.125	0.684

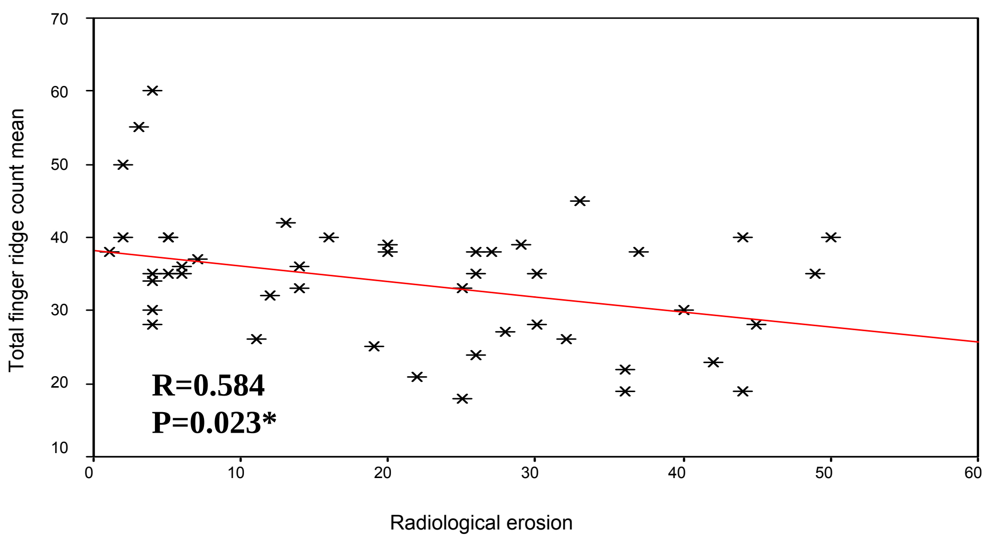

Fig. (7): Correlation between RA male patients with radiological erosion and total finger ridge count mean.

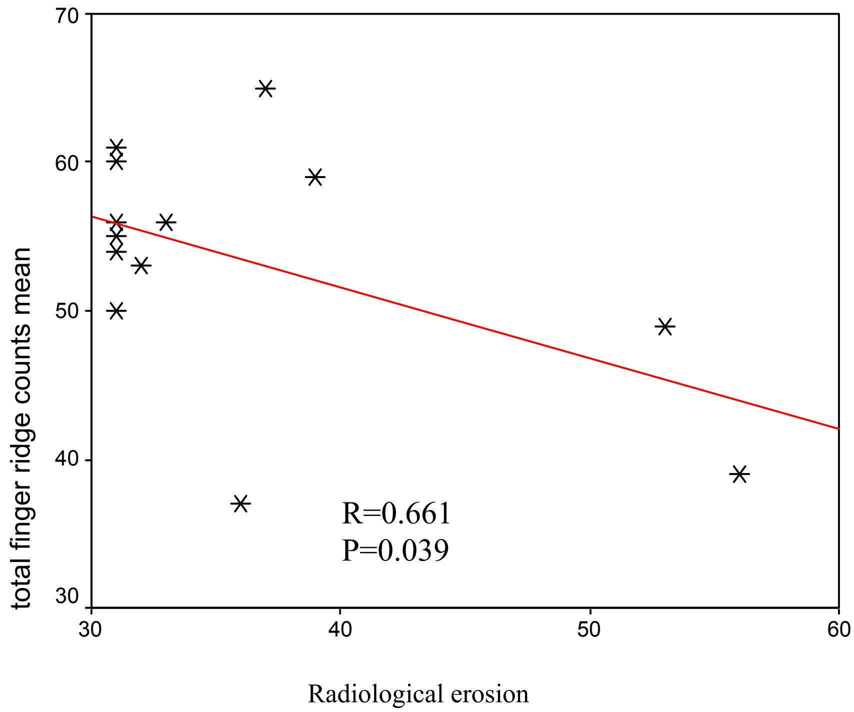

Fig. (8): Correlation between RA female patients with radiological erosion and total finger ridge count mean.

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4. DISCUSSION

Different qualitative dermatoglyphic patterns were studied in this work. It was noticed that loops were the most common type observed in normal individuals followed by whorls, and lastly arches. Similarly, *Igbigbi and Msamati (2002)* demonstrated that ulnar loops were the most predominant digital pattern type in both sexes followed by whorls in males and arches in females. Their study documented similarities in digital ridge patterns between some African countries indicating their close historical and anthropological relationship. However, significant differences were demonstrated between them and Europeans. These results emphasize that digital patterns are specific in differentiating ethnic and population groups.

In the present work, ulnar loops were significantly decreased in both hands of both sexes of RA patients compared with controls, however, radial loops showed non significant changes. Going in line with these results, *Taneja et al., (1993)* reported a significant decrease in ulnar loops in the right hand of females and both hands of male patients with RA. Radial loops showed also significant decrease in both hands of male patients. In another study conducted on finger print patterns on individual fingers of RA patients, loops were especially decreased in the 3rd finger of males and in the 1st and 4th fingers of females *(Ravindranath et al., 2003)*.

In the present work, arches were significantly increased in both hands of male and female patients. This finding was partially coincided with *Taneja et al., (1993)* who reported an increase in arches on both hands of females and left hand only of males. Also, *Ravindranath et al., (2003)* noted that with both hands together, arches were significantly increased in male patients but female patients showed significant increase only in some individual fingers (3^{rd} and 4^{th} fingers). *Todd et al., (2006)* mentioned that the embryologic timing of the ridge pattern formation was associated with the type of dermatoglyphic pattern development. Early ridge formation was associated with whorls, late formation with arches, and intermediate formation with loops. They suggested that clinical syndromes which arrested embryologic development and decreased developmental maturation tend to have more arches and fewer whorls.

Regarding whorls, non significant change was noticed in the present work, not only in females but also in male patients. In a previous study, frequency of whorls was reported to be increased on the right hand of male, and both hands of female RA patients *(Taneja et al., 1993).* This was in contrast to the study conducted by *Ravindranath et al., (2003)* on RA who found significant decrease in whorls in both hands of males and non significant change in females.

The main pattern intensity (number of triradii in all fingers) was also considered for correlation in the present study. It was decreased in RA patients than controls in both sexes. However, it was significant in left hand of males and right hand of females. Reviewing the available literature, the relation between pattern intensity and RA disease was not reported. The decreased number of triradii (pattern intensity) observed in this study can be explained by the decreased whorls (each whorl has two triradius) and significant increase in arches (the arch has no triradius) noticed in RA patients.

Although *Taneja et al., (1993)* did not observe any difference between RA patients and controls regarding the total finger ridge count, the results of *Rajangam et al., (2008)* showed a significant increase of the total ridge count only in the right hand of male patients. In the present study total finger ridge count was decreased in patients as compared to controls and this decrease was statistically significant in left hand of males and right hand of females.

The mean a-b ridge count of the palm of RA patients was also decreased in both hands of males and females when compared to the controls. This finding don't coincides neither with *Taneja et al., (1993)* who did not observe any significant difference between patients of rheumatoid arthritis and controls for the a-b ridge count, nor with *Rajangam et al., (2008)* who noted a significant increase in the a-b ridge count in both male and female patients.

It was suggested that the a-b ridge count is more environmentally determined and less hereditable than other dermatoglyphic traits such as finger tips patterns. The a-b ridge count is sensitive to environmental stress because the area of the palm in which a-b ridge count is situated, the second interdigital region, begins to develop earlier than the fingers and its progression is more slowly. Thus the ridges in this region may develop over a longer period of time, exposing the area to potential environmental insult. On the other hand, total ridge count appears to be under relatively strong genetic control and little influenced by environmental factors *(Fearon et al., 2001).* In the present work, the significant decrease in both a-b ridge count and total finger ridge count in RA patients confirm that RA disease is influenced by both genetic and environmental factors.

The distribution of unusual palmer flexion creases in patients and controls was also studied in this work. Sydney line, Simian and partial Simian creases were the most frequent creases observed, however, significant increase was noticed only in Sydney line of female patients right hand. In the study conducted by *Ravindranath et al., (2003)*, partial Simian crease was the only significantly increased unusual pattern in male patients, while Sydney line was absent in both males and females.

In the field of anthropology, researchers found that there are divergences of different degrees between races, nationalities, and even populations. Diagnosis on individuals of different nationalities cannot use the same standards *(Hui et al., 2003).* Significant correlation between dermatoglyphics and geographic distances was also noticed by *Natekar et al., (2006).* This may explain the presence of variations between different results in this field. Dermatoglyphics by themself are not enough to diagnose RA disease but the results of this work suggest that dermatoglyphics can at least serve to strengthen the diagnostic impression about RA disease especially in unidentified patients or those with early signs of joint inflammation.

Dermatoglyphic deviations observed in the present work were tested for correlation with radiologic diagnosis. The mean total finger ridge count showed significant inverse correlation with radiographic erosion. This finding indicates that this specific dermatoglyphic variable may help to predict the aggressive type of RA disease. Moreover, the significant correlation between radiographic erosion and total ridge count observed in this work together with the suggestion of *Fearon et al., (2001)* that total ridge count appears to be under relatively strong genetic control and little influenced by environmental factors lead us to the suggestion that erosive changes in RA was more likely to be due to genetic causes. So, it is possible to estimate the individual predisposition to this aggressive type of the disease and thus to guide therapy decisions early to attenuate cumulative inflammation as soon as symptoms appear.

5. Conclusion:

The findings of the present work demonstrate the association between some dermatoglyphic patterns and RA disease suggesting that dermatoglyphics can represent an anatomical, non-invasive, inexpensive tool for screening high-risk population, and thus facilitate early detection and management. Also the relationship between total ridge count and the aggressive type of RA indicate that this dermatoglyphic variable might play a significant role not only for screening but also for studying the behavior of the disease. Further studies are recommended to support our findings regarding the importance of dermatoglyphics as an anatomical marker in rheumatoid arthritis.

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