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Assessment of Finger and Palmar Dermatoglyphics in Thalassemia Patients in Gujarat: A Search for Diagnostic Traits

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ABSTRACT

Background: Thalassemia is a common hereditary blood disorder with a high prevalence in India. Dermatoglyphics, the study of epidermal ridge patterns, has shown potential as a noninvasive indicator of various genetic conditions. This study aims to evaluate finger and palmar dermatoglyphic patterns in patients with thalassemia and assess their potential diagnostic significance.

Objectives: To analyze finger and palmar dermatoglyphic features in thalassemia patients and identify whether specific dermatoglyphic traits are consistently associated with the disease.

Materials and Methods: This observational, cross-sectional study included 60 clinically diagnosed thalassemia patients attending the Thalassemia OPD at Civil Hospital, Ahmedabad, during February and March 2013. Detailed clinical data were recorded. Finger and palmar prints were obtained using the ink method described by Cummins and Midlo. Total finger ridge count (TFRC), absolute finger ridge count (AFRC), 'atd' angle, 'ab' and 'cd' ridge counts, and fingerprint patterns were analyzed.

Results: Among 600 fingertip patterns studied, ulnar loops were the most frequent (56.5%), followed by whorls (32.2%), arches (8.7%), and radial loops (2.6%). The mean TFRC and AFRC were 117.2 and 148.6, respectively. The mean 'atd' angle was 42.4° in the right hand and 44.3° in the left. Increased 'ab' and 'cd' ridge counts were also noted. These findings showed a predominance of loop patterns and increased ridge parameters, in line with previous literature.

Conclusion: Dermatoglyphic traits such as increased ulnar loops, ridge counts, and wider 'atd' angles are more common in thalassemia patients. These features may serve as useful adjunct markers for screening and early identification, especially in resource-limited settings.

Keywords: *Thalassemia, Dermatoglyphics, Fingerprint patterns, Ridge count, 'atd' angle, Genetic screening.*

1. INTRODUCTION

Thalassemia is one of the most common inherited hemoglobin disorders, characterized by partial or complete deficiency in the synthesis of alpha or beta globin chains, leading to chronic hemolytic anemia of varying severity [1]. It is particularly prevalent in India, with certain regions such as Gujarat reporting higher carrier frequencies due to endogamy, consanguinity, and lack of effective screening programs [2,3]. Early detection remains a cornerstone of prevention, yet resource-limited settings demand supplementary, costeffective, and non-invasive diagnostic approaches.

Dermatoglyphics—the scientific study of epidermal ridge patterns on fingers, palms, and soles—was first coined by Cummins and Midlo in the early 20th century [4]. These patterns are genetically determined and formed by the 13th week

of intrauterine life, remaining unchanged throughout an individual's lifespan [5]. Because dermatoglyphic traits reflect underlying genetic structures, they have been explored as potential markers for several hereditary and chromosomal disorders such as Down syndrome, Turner syndrome, and congenital heart diseases [6–8].

Several studies have investigated the dermatoglyphic profiles of patients with thalassemia, revealing distinctive variations in fingerprint types, total finger ridge counts (TFRC), and palmar features like the atd angle and main line terminations [9–11]. These findings suggest that dermatoglyphics may offer a supplementary, non-invasive tool to aid in the identification or screening of individuals at risk for thalassemia. However, dermatoglyphic traits may exhibit ethnic, regional, and environmental variability, necessitating population-specific studies to validate their diagnostic relevance [12].

In this context, the present study aims to assess the finger and palmar dermatoglyphic patterns in thalassemia patients from Gujarat and to explore whether distinct dermatoglyphic features exist that may aid in early detection or risk prediction.

2. MATERIALS AND METHODS

Type of Study

This was a descriptive, observational cross-sectional study conducted to assess dermatoglyphic patterns in thalassemia patients.

Study Design and Participants

The study was conducted on 60 confirmed cases of thalassemia (40 males and 20 females) attending the Thalassemia Outpatient Department at Civil Hospital, Ahmedabad, during the months of February and March 2023.

Detailed information was collected for each participant including name, age, sex, onset and type of illness, personal and family history, and clinical assessment. All relevant routine and specific investigations for thalassemia, including karyotyping, were reviewed. Dermatoglyphic analysis was performed for each case.

Ethical Clearance

Prior to the commencement of the study, ethical approval was obtained from the Institutional Ethics Committee. Informed written consent was obtained from all participants or their legal guardians, in accordance with the ethical standards of the Declaration of Helsinki.

Inclusion Criteria

- Clinically and laboratory-confirmed cases of thalassemia attending the OPD during the study period.
- Patients or guardians willing to provide informed consent.

Exclusion Criteria

- Patients refusing to give consent.
- Individuals with amputated fingers.
- Cases with hand deformities or injuries that hindered dermatoglyphic assessment.

Dermatoglyphic Printing Technique

Dermatoglyphic prints were obtained using the Ink Method, as described by Cummins (1936) and Cummins & Midlo (1961). This method was chosen for its simplicity, low cost, clarity of prints, and time efficiency.

Materials Required as shown in Figure 1

- Ink slab
- Inverted ‘T’ shaped pad Kore’s duplicating ink
- White paper sheets
- Rubber roller
- Soap and water
- Magnifying glass
- Protractor and scale
- Pencil
- Sharp-pointed needle (for ridge counting)

Figure 1: Material required for taking palm prints

Procedure as shown in Figure 2 and 3

1. Hands were washed thoroughly with soap and dried.
2. Ink was evenly spread on the ink slab using a rubber roller.
3. Each finger was rolled laterally on the ink slab and then onto the white paper to obtain prints.
4. For palmar prints, ink was applied evenly on the palm, and the hand was rolled from wrist crease to fingertips on paper fixed over a roller pad.
5. The same steps were repeated for both hands.
6. Prints were analyzed using a magnifying glass and a needle for ridge counting. Observations were noted on the same print sheet.

Figure 2: Method of taking palm print and Finger printing

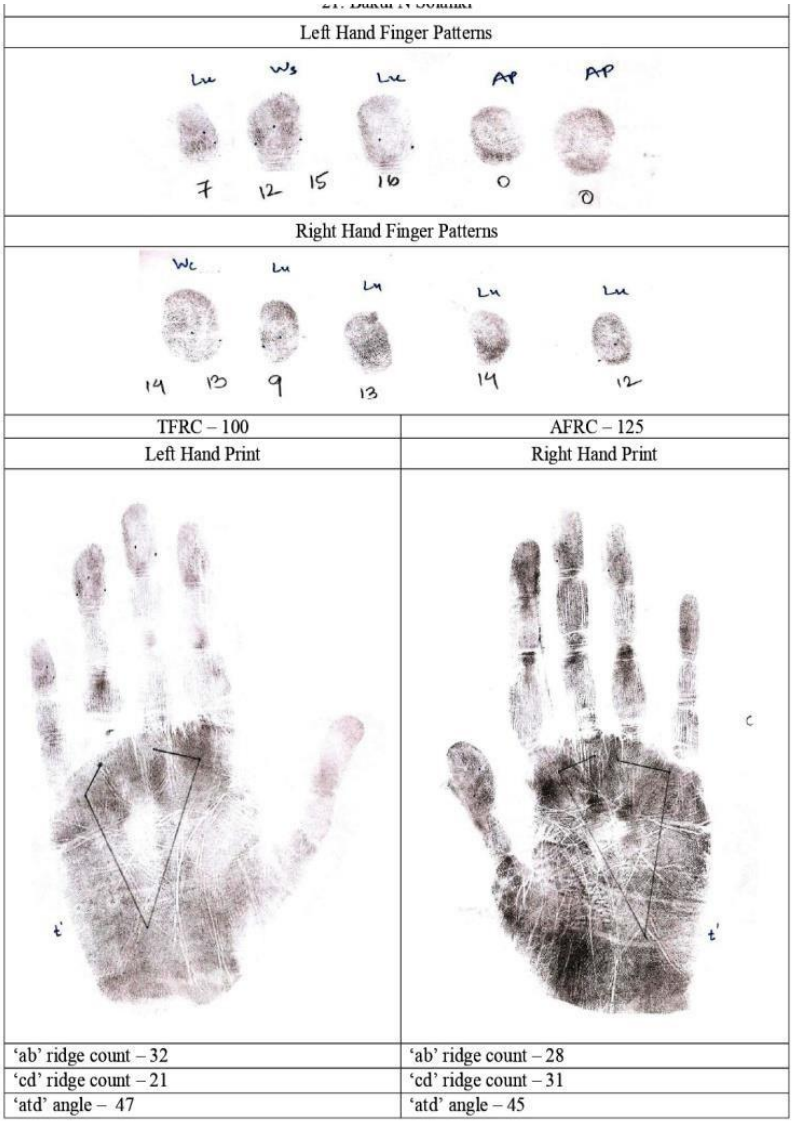

Figure 3 Showing patient Palm printing and Finger Printing

Ridge Counting Method

Ridge counts were made by drawing a straight line from the triradius to the core, excluding the triradial and core points themselves.

- For whorls with two triradii, two ridge counts were taken and the larger value was recorded.
- Arches (simple and tented) were given a count of '0'.

Total Finger Ridge Count (TFRC):

TFRC is the sum of the highest ridge count from each of the 10 digits. It reflects pattern size.

Absolute Finger Ridge Count (AFRC):

AFRC includes all ridge counts from each triradius, reflecting both size and pattern complexity.

Palmar Dermatoglyphic Parameters

Triradii:

- Axial triradii (t, t′, t″) are located near the wrist crease.
- Digital triradii (a, b, c, d) are located at the base of fingers 2–5.

Ridge Counts:

- ab Ridge Count: Number of ridges between triradii 'a' and 'b'.
- cd Ridge Count: Number of ridges between triradii 'c' and 'd'.

atd Angle:

- The atd angle is formed by connecting triradii a–t–d.
- It reflects the distal displacement of the axial triradius.
- A normal atd angle is approximately 45°.
- In cases with multiple axial triradii, the most distal triradius was used for angle measurement.

3. RESULTS

The present observational study was conducted on 60 clinically diagnosed thalassemia patients, attending the Thalassemia Outpatient Department at Civil Hospital, Ahmedabad as shown in table 1.

Parameter	Category/Subgroup	No. of Patients	Percentage (%)
Age Group (years)	11–15	18	30.00
	15–20	34	56.67
	21–25	4	6.67
	25–30	4	6.67
Sex Distribution	Male	40	66.67
	Female	20	33.33
Type of Thalassemia	Beta Thalassemia Minor	40	66.67
	Beta Thalassemia Major	16	26.67
	Alpha Thalassemia Minor	4	6.67
Age at Diagnosis	At birth	2	3.33
	Within first 2 years	16	26.67
	After 2 years	42	70.00
Family History	Positive	50	83.33
	Negative	10	16.67
Parental Consanguinity	Present	12	20.00
	Absent	48	80.00
Hemoglobin Level	< 7.0 g/dL (Severe Anemia)	8	13.33
	7.0–9.0 g/dL (Moderate	40	66.67
	Anemia)		
	> 9.0 g/dL (Mild Anemia)	12	20.00
Hematocrit (%)	< 15%	10	16.67
	15–35%	44	73.33
	> 35%	6	10.00
Splenomegaly (USG/clinical)	Just palpable (+)	14	23.33

	Moderately enlarged (++)	36	60.00
	Huge (+++)	10	16.67

Table 1: Combined Clinical and Hematological Profile of Thalassemia Patients Attending Thalassemia Clinic, Civil Hospital, Ahmedabad (n = 60)

Demographic Distribution

The majority of patients (86.67%) belonged to the 11–20 years age group, with 18 patients (30%) in the 11–15 year group and 34 patients (56.67%) in the 15–20 year group. Only 8 patients (13.33%) were older than 20 years. Among the study population, there was a male predominance with 40 males (66.67%) and 20 females (33.33%), reflecting a 2:1 male-tofemale ratio.

Types and Diagnosis of Thalassemia

The distribution of thalassemia types showed that Beta Thalassemia was the most common variant: 40 patients (66.67%) had Beta Thalassemia minor, 16 (26.67%) had Beta Thalassemia major, and 4 patients (6.67%) had Alpha Thalassemia minor.

In terms of diagnosis timing, most patients with Beta Thalassemia major (14 out of 16) were diagnosed within the first two years of life, while Beta Thalassemia minor and Alpha Thalassemia minor were diagnosed after two years of age in the majority of cases.

Family History and Parental Consanguinity

A positive family history of thalassemia was found in 50 patients (83.33%), and 12 patients (20%) had a history of consanguineous marriage among parents, indicating a strong genetic predisposition.

Anemia Profile

Hemoglobin levels revealed that 40 patients (66.67%) had moderate anemia (Hb 7–9 g/dL), 8 patients (13.33%) had severe anemia (Hb <7 g/dL), and 12 patients (20%) had mild anemia (Hb >9 g/dL).

Hematocrit values showed that 44 patients (73.33%) had hematocrit between 15–35%, 10 patients (16.67%) had values <15%, and 6 patients (10%) had values >35%, which correlated with the severity of anemia and thalassemia type.

Splenomegaly

Clinically and ultrasonographically, 36 patients (60%) had moderate splenomegaly, while 10 patients (16.67%) had massive splenomegaly, of which most were Beta Thalassemia major cases. 14 patients (23.33%) had a just palpable spleen.

Dermatoglyphic analysis was carried out on all 60 thalassemia subjects, encompassing a total of 600 fingertip impressions. As shown in table 2

Parameter	**Category / Range**	**No. of Subjects / Prints**	**Percentage (%)**
Fingerprint Patterns	Ulnar Loops	338 prints	56.3%
	Whorls	196 prints	32.7%
	Arches	54 prints	9.0%
	Radial Loops	12 prints	2.0%
Total Finger Ridge Count (TFRC)	116–135 (Most common range)	22 subjects	36.7%
	Other Ranges (56– 175)	38 subjects	63.3%
Absolute Finger Ridge Count (AFRC)	101–150 (Most common range)	24 subjects	40.0%
	Other Ranges (51– 300)	36 subjects	60.0%
‘atd’ Angle (Right Hand)	41–45°	20 subjects	33.3%
	36–40°	20 subjects	33.3%
‘atd’ Angle (Left Hand)	41–45°	24 subjects	40.0%

'ab' Ridge Count	36–40 (Right Hand)	20 subjects	33.3%
	36–40 (Left Hand)	18 subjects	30.0%
'cd' Ridge Count	36–40 (Right Hand)	20 subjects	33.3%
	31–35 (Left Hand)	16 subjects	26.7%

Table 2: Combined Dermatoglyphic analysis of Thalassemia Patients Attending Thalassemia Clinic, Civil Hospital, Ahmedabad (n = 60)

The most common fingerprint pattern observed was ulnar loops, found in 338 (56.3%) prints, followed by whorls in 196 (32.7%), arches in 54 (9%), and radial loops in only 12 (2%) prints. This distribution suggests a predominance of loop patterns in thalassemia patients.

Analysis of Total Finger Ridge Count (TFRC) revealed that 22 subjects (36.67%) had a

TFRC in the range of 116–135, with a mean TFRC of 116.6. Likewise, the Absolute Finger Ridge Count (AFRC) was between 101–150 in 24 subjects (40%), and the mean AFRC was found to be 147.5.

The 'atd' angle, which reflects the position of the axial triradius, showed that 41–45° was the most frequently observed range in both hands—20 subjects (33.3%) in the right hand and 24 subjects (40%) in the left hand. The mean 'atd' angle was 42.26° in the right hand and 44.26° in the left hand, indicating a slight left-sided increase.

For the 'ab' ridge count, values most frequently fell within the 36–40 range in both hands— 20 subjects (33.3%) on the right and 18 subjects (30%) on the left. The mean 'ab' ridge count was 36.8 for the right hand and 38.4 for the left. Similarly, 'cd' ridge count was highest in the 36–40 range in the right hand (20 subjects) and in the 31–35 range in the left hand (16 subjects). The mean 'cd' ridge count was 34.06 in the right hand and 37.33 in the left hand.

Overall, the dermatoglyphic traits of thalassemia patients in this study showed consistency in ridge counts, predominance of ulnar loop patterns, and relatively higher 'atd' angles, which may suggest diagnostic relevance when compared with non-thalassemic controls.

4. DISCUSSION

Thalassemia remains one of the most prevalent inherited hemoglobinopathies worldwide, with a particularly high frequency in South Asia, including India. The burden of disease calls for robust strategies in carrier detection, population screening, premarital counseling, and prenatal diagnosis. Dermatoglyphics, as a non-invasive and cost-effective tool, has been explored in this context to assess its diagnostic potential. In the present study, 60 clinically diagnosed cases of thalassemia were evaluated, with detailed clinical, hematological, and dermatoglyphic analysis. The findings were compared with those of previously published studies.

Age at Diagnosis

Being an inherited disorder, thalassemia can be identified prenatally through procedures like chorionic villus sampling (CVS) at 9–10 weeks or amniocentesis. Early diagnosis is especially crucial in beta-thalassemia major, where early transfusions and chelation therapies improve outcomes. In the present study, 14 out of 16 (87.5%) beta-thalassemia major patients were diagnosed within the first two years of life, consistent with findings by Ibrahim Kesar et al. (2000), where 26 out of 77 beta-thalassemia major cases were diagnosed before two years of age [13]. Similarly, Dogramaci et al. (2009) reported that 46 of 59 beta-thalassemia major patients were diagnosed within the same early period [14]. In contrast, the majority of betathalassemia minor and alpha-thalassemia minor patients were diagnosed later, often incidentally or during family screening, emphasizing the silent nature of the carrier state.

Family History of Thalassemia

A significant number of subjects in this study (50 out of 60, i.e., 83.3%) reported a positive family history of thalassemia, indicating high familial clustering. This is in accordance with Khattak et al. (2006), who found that 450 out of 600 thalassemia patients had a positive family history [15]. A similar trend was observed in the study by K.Y. Tse et al. (2002), where 1120 out of 1187 fetuses born to thalassemic couples were affected [16]. These findings reinforce the importance of genetic counseling and targeted screening in families with known thalassemia cases.

Parental Consanguinity

Parental consanguinity significantly increases the risk of autosomal recessive disorders such as thalassemia. In the present study, 12 out of 60 patients (20%) were born to consanguineous parents. This figure, while lower than some other reports, still highlights a preventable risk factor. For example, Saleem et al. (1996) noted that Pakistan has the world's highest number of thalassemia births, largely due to high consanguinity and fertility rates [17]. Zehanzeb Khan et al. (1999) reported

consanguinity in 72% of thalassemia cases [18]. The data suggest that while consanguinity may not be the sole factor in India's thalassemia burden, it remains an important contributor in certain regions.

Splenomegaly

Splenomegaly is a frequent clinical finding in thalassemia, particularly in beta-thalassemia major, due to persistent hemolysis and extramedullary hematopoiesis. In the present study of 60 patients, 18 (30%) were found to have moderately enlarged spleens, while 5 (8.3%) had huge splenomegaly. Among those with massive splenomegaly, 4 patients (80%) were diagnosed with beta-thalassemia major, reflecting the severity of disease in these individuals.

This pattern correlates with the findings by Sabih Salih Mehdi (2009), who reported that among 105 beta-thalassemia major patients, 52 had moderate to severe splenomegaly, while 53 showed only palpable spleens [19]. Similarly, Karimi et al. (2009) noted that among 185 beta-thalassemia minor cases, 74 had mild to moderate splenomegaly, emphasizing that spleen enlargement is not limited to thalassemia major, though more pronounced in severe phenotypes [20].

Hematological Parameters

Hemoglobin estimation is a primary indicator of anemia severity in thalassemia. In our study, 20 patients (33.3%) had hemoglobin levels in the range of 7.0–9.0 g/dL, representing moderate anemia. Additionally, 4 patients (6.7%) had hemoglobin <7.0 g/dL, indicating severe anemia, and 6 patients (10%) had levels >9.0 g/dL, classified as mild anemia.

This distribution is in alignment with prior reports. Sabih Salih Mehdi (2009) documented that out of 105 beta-thalassemia major cases, 75 had hemoglobin between 7.0–9.0 g/dL, 14 had values below 7.0 g/dL, and 16 were above 9.0 g/dL [21]. Likewise, Dogramaci et al. (2009) found similar trends, with 40 out of 59 beta-thalassemia major patients exhibiting moderate anemia, **6** with severe anemia, and 13 with mild anemia [14].

These findings highlight the substantial hematologic burden in thalassemia and reinforce the need for regular monitoring, transfusion planning, and early detection of complications like hypersplenism and iron overload.

Dermatoglyphic Findings

Dermatoglyphic traits, being genetically regulated and fixed early during embryogenesis, have been investigated in various congenital and genetic disorders, including thalassemia. Several past studies have highlighted distinctive dermatoglyphic patterns in thalassemia patients, and similar trends were observed in the current study involving 60 clinically diagnosed cases.

Fingerprint Patterns

In the present study, ulnar loops were the most prevalent fingerprint pattern, observed in 56.3% of the 600 fingertip impressions, followed by whorls (32.7%), arches (9%), and radial loops (2%). This finding aligns closely with previous studies:

- Dallapiccola et al. (1975) first reported an increased frequency of loops and decreased whorls in patients with Cooley's anemia, along with an elevated 'atd' angle [22].
- Saha et al. (1979) and Mutalimova et al. (1989) also observed a higher prevalence of loop patterns, consistent with our findings [23, 24].
- More recent studies by A.K. Bhalla et al. (2005)**,** Dogramaci et al. (2009)**,** and Hasan Solhi et al. (2010) corroborated the significant increase in ulnar loops in thalassemia patients [25, 14, 26].

Total Finger Ridge Count (TFRC) and Absolute Finger Ridge Count (AFRC)

In this study, the mean TFRC was 116.6, and the mean AFRC was 147.5, which are consistent with the values reported by Mahato Lata Omprakash et al. (2013), who noted higher TFRC and AFRC in thalassemia patients as compared to healthy controls [27]. These elevated counts may be reflective of genetic influences in thalassemia affecting epidermal ridge development.

'atd' Angle

The 'atd' angle is widely studied in genetic disorders due to its variability in conditions affecting embryonic growth. In our study, the mean 'atd' angle was 42.26° in the right hand and 44.26° in the left**,** with 40 of the 60 patients (66.6%) having values between 36° and 45°**,** similar to values reported by:

- Venkataratnam et al. (1995), who found most 'atd' angles in the range of 41°–45° in thalassemia patients [67].
- Dogramaci et al. (2009) and Dr. Andani et al. (2012), both of whom reported significantly increased 'atd' angles in thalassemia cases [18, 2].

'ab' and 'cd' Ridge Counts

In this study, the mean 'ab' ridge count was 36.8 (right hand) and 38.4 (left hand), and the mean 'cd' ridge count was 34.06 (right) and 37.33 (left). The most common range for both

'ab' and 'cd' ridge counts was 31–40, found in over half the cases, consistent with the findings of:

- K. Venkataratnam et al. (1995) and Dogramaci et al. (2009), who found similar distributions of 'ab' and 'cd' counts in thalassemia patients [28, 14].
- Dr. Andani et al. (2012), who observed mean 'ab' ridge counts of 32.16 (right) and 33.38 (left), further supporting the trend [29].

Author	Main Findings
Dallapiccola et al. (1975) [22]	Increased loops, decreased whorls, larger 'atd' angle
Saha et al. (1979) [23]	Increased loop patterns
Mutalimova et al. (1989)	Increased loops and larger 'atd' angle
[24]	
Venkataratnam et al. (1995) [28]	Increased 'cd' ridge count, larger 'atd' angle
A.K. Bhalla et al. (2005) [25]	Increased ulnar loops, TFRC, 'ab' and 'cd' ridge counts
Dogramaci et al. (2009) [14]	Elevated ulnar loops, 'ab' and 'cd' ridge counts, 'atd' angle
Hasan Solhi et al. (2010) [26]	Increased loops, 'ab', 'cd' ridge count, and 'atd' angle
Dr. Andani et al. (2012) [29]	Increased 'ab' ridge counts, larger 'atd' angles
Mahato Lata Omprakash et al. (2013) [27]	Higher loops, TFRC, and AFRC
Present Study (2025)	Ulnar loop predominance, increased 'ab', 'cd' ridge counts, and mean 'atd' angle similar to prior studies

Table 3 Comparison of main Dermatoglyphics findings of various studies

Limitations of the study :- The present study has certain limitations. The sample size, though increased to 60 patients, remains relatively small, limiting the generalizability of the findings. The absence of an age- and sex-matched healthy control group restricts comparative analysis.

5. CONCLUSION

The present study highlights that specific dermatoglyphic features—such as a higher frequency of ulnar loops, increased total and absolute finger ridge counts, larger 'atd' angles, and elevated 'ab' and 'cd' ridge counts—are more prevalent in thalassemia patients. These findings are consistent with previous studies and suggest that dermatoglyphics can serve as a supportive, non-invasive screening tool in identifying individuals at risk for thalassemia. While not diagnostic on their own, dermatoglyphic patterns may assist in early detection and genetic counseling, especially in regions with high disease prevalence. Further studies with larger sample sizes and proper controls are recommended to validate these findings.

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