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Palmar a-b ridge count in E-β thalassemia patients: A study on the Bengalee Hindu Caste Populations of West Bengal, India

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ABSTRACT

Apart from the unique value of finger prints for personal identification, dermatoglyphics has been utilized as valuable marker trait and its diagnostic value for different genetic disorders is well documented. Several studies have reported the importance of dermatoglyphics as markers of a prenatal disturbance due to the fact that finger and palmar dermatoglyphics characteristics are formed by the end of the second trimester, they may provide evidence of disturbances in early development. To best of the knowledge, the present study is the first attempt to understand the association of palmar a-b ridge count among the E-β thalassemia patients. To achieve the purpose finger and palm prints of 70 (Male-35, Female-35) diagnosed E-β thalassemia patients were obtained from Hindu caste Bengalee population of Howrah district, West Bengal. Apart from thalassemia patients, 70 (Male-35, Female-35) apparently healthy individuals without any family history of thalassemia as controls have also been collected from Bengalee Hindu caste population of the same area. Bilateral palm prints of all the participants were collected by using standard ink and roller method. For the present purpose a-b ridge count (ABRC) of each palm and total a-b ridge count (TABRC) of the E-β thalassemia patients and the controls have been evaluated using standard method. The results revealed significantly ($p<0.05$) higher ABRC and TABRC among E-β thalassemia patients than the controls, and consequently indicated greater distance between palmar a and b interdigital triradii among the E-β thalassemia patients. Furthermore, significant ($p<0.05$) increase of ABRC was found among the male patients than that of female patients along with significant ($p<0.05$) bilateral asymmetry for ABRC among the female E-β thalassemia patients. However, no such sexual dimorphism and bilateral asymmetry for ABRC was revealed among the controls. Therefore, the present study envisaged that palmar a-b ridge count might be one of the imperative characteristics as diagnostic criteria of E-β thalassemia.

Key words: *Dermatoglyphics, a-b ridge count, E-β-thalassemia, Bengalee population, bilateral asymmetry*

INTRODUCTION

Inclusion of the methodologies of population genetics in contemporary biological anthropology further extended the horizon of research work on genetically determined normal traits. Nevertheless, these obvious traits can greatly impact Quality Adjusted Life Years (QALY) in a variety of ways, and can impact studies of common diseases (causal and/or diagnostic). Among those the dermal patterns are very useful as these patterns are highly heritable, durable, and age-independent human traits (Bonnevie 1924; Cummins and Midlo 1926). In dermatoglyphics, the configurations include the finger print, palm print and the toe print (Book 1957). The dermatoglyphic traits most commonly used are qualitative descriptions dividing digit patterns as well as quantitative counts of ridges on digits and palms (Cummins and Midlo 1926). However, subsequently, it has been reported that the palm prints being more informative (Cummins and Midlo 1943) as palmar creases develop during the second and third month of intrauterine life and are not influenced by movement of hand in utero (Alter 1970). These epidermal ridge patterns were found to be of considerable clinical interest as they are affected by certain abnormalities during early development including genetic disorders (Walker 1958). Dermatoglyphics attracted a great number of scientists from all sections of biology, medicine and biological anthropology (Chen *et al.,* 2008) and greater association between dermatoglyphics and diseases or congenital abnormalities have also been extensively studied (Tarca 2001; Kumar *et al.,* 2003; Miliĉiċ *et al.,* 2003; Saha *et al.,* 2003). In fact, dermatoglyphics could be used as accessible technique to assess genetically determined diseases (Penrose 1968; Miliĉiċ *et al.,* 2003; Temaj *et al.,* 2009). Abel (Abel 1938) first showed a direct relationship between number of ridges and length of the distal phalanges in adults and suggested that both were independent of pattern type and size. Later on, Babler (1987) demonstrated developmental relationships between epidermal ridges and the developing bone skeleton of the hand. The study revealed significant prenatal relationship between epidermal ridge dimension and bone dimension of the hand. Therefore, relationship of bone dimension and volar pad topography has been found to have concomitant effect (Bonnevie 1924). Thalassemia being one of the major blood disorders and having pleiotropic effect on skeletal conditions might influence the dermatoglyphic features. The worldwide prevalence of α- and β-thalassemia trait is about 1.7% and both males and females are equally affected. The incidence of thalassemia trait is 4.4 per 10,000 live births. β-thalassemia in its various presentations is more common in the Mediterranean area, Africa, and South eastern Asia (Rund and Rachmilewitz 2005). About 10% of total world thalassemia patients belong to Indian

subcontinent, among them 3-4% are carrier (Sinha *et al.,* 2009). The studies of qualitative and quantitative dermatoglyphic traits specially the digital patterns had been efficiently demonstrated significant association with thalassemia (Dallapiccola *et al.,* 1975; Dogramaci *et al.,* 2009; Solhi *et al.,* 2010; Das and Bandyopadhyay 2014b). β-thalassemia is an autosomal recessive disorder characterized by hypochromic hemolytic anemia and dependence on blood transfusions to sustain life. The disease causes significant morbidity and mortality in affected individuals, burdening not only the patient and the family but also the National Health Service. It is caused by mutations that reduce or abolish the synthesis of β-globin chains required for the formation of adult haemoglobin (HbA - $\infty_2\beta_2$). β-Thalassemia is the commonest single gene disorder in India (Verma 1994). Therefore, the control of β-thalassemia has become one of the major thrust areas among all hemoglobinopathies in India (Vaz *et al.,* 2000). The present scenario of West Bengal has a prevalence of β-thalassemia about 3.60 to 5.95% (Mohanty *et al.,* 2013).

In Indian context both qualitative and quantitative dermatoglyphics variables based on finger dermatoglyphic variables revealed curious features among thalassemia patients with expected population variability (Saha *et al.,* 1973; Bhalla *et al.,* 2004; Mahato *et al.,* 2006; Dehankar and Ksheersagar 2006). Moreover, different studies mainly on quantitative dermatoglyphic traits of fingers among the β-thalassemia patients demonstrated noteworthy features (Saha *et al.,* 1973; Bhalla *et al.,* 2004; Das and Bandyopadhyay 2014a). However, in the context of palmar dermatoglyphic traits in recent years a-b ridge count has been extensively studied in different disorders such as schizophrenia (Bramon *et al.,* 2005), diabetes mellitus (Rakate *et al.,* 2013), myocardial infarction (Manara *et al.,* 2011), albinism (Ghodsi *et al.,* 2012), epilepsy (Lal and Sureka 2012), bronchial asthma (Mahajan and Gour 2011) and thalassemia (Bhalla *et al.,* 2004; Andani *et al.,* 2012). To best of the knowledge the present paper is the maiden attempt to understand the association between palmar dermatoglyphic traits in terms of a-b ridge count on the E- β-thalassemia patients from Howrah district of West Bengal.

MATERIALS AND METHODS

The participants of the present study consists of 70 (Male-35, Female-35) diagnosed E-β thalassemia patients of Bengalee Hindu Caste population of Howrah district of West Bengal. On the other hand, participated 70 (Male-35, Female-35) controls were from the same area and population with no history of thalassemia in the family. Bilateral palm prints of each individual

were collected according to the widely used traditional ink method proposed by Cummins and Midlo (1926). The a-b ridge count has been evaluated following standard technique (Schaumann and Alter 1976). The a-b interdigital ridge count (ABRC) was defined as the number of ridges that cross a line drawn between triradii a and b. The ABRC is a measure of the second interdigital area of the hand. It is measured by counting 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. The Total a-b interdigital ridge count (TABRC) has been determined by adding both the left and right ridge counts. In addition to that, socio demographic variables regarding age, sex, caste affiliation, occupation and family history of thalassemia were recorded in specially prepared pre tested schedule. From the each participant written and /or verbal consent regarding the present work has also been obtained and the present work has obtained ethical committee clearance from University of Calcutta. All the data were cross checked and analyzed in SPSS (version 17.0) for descriptive statistics and inferential statistics. Cut off value were set as $p = 0.05$.

RESULTS

In the present study Table 1 revealed significant ($p<0.05$) difference between male and female E-β thalassemia patients regarding ABRC due to higher ABRC among the males for right hand. However, TABRC of males also demonstrated significantly ($p<0.05$) higher TABRC compared to that of female patients. Furthermore, gender differences have been noticed as significant ($p<0.05$) bilateral asymmetry was only present among the female patients due to increased number of ridges in the left hand of the female patients. However, no such phenomenon of sexual dimorphism has been noticed for ABRC and TABRC among the controls (Table 2) and as well as bilateral asymmetry was not observed among the controls. Comparison of a-b ridge count of the E-β thalassemia patients and controls (Table 3), demonstrated significant ($p<0.05$) difference, and indicated higher ABRC and TABRC among the E-β thalassemia patients in comparison to the controls for both the right and left hands. Eventually, this significantly ($p<0.05$) higher ABRC and as well as TABRC among the E-β thalassemia indicated greater distance between palmar a and b triradii i.e. greater second interdigital area than controls.

Table 1: Distribution of a-b ridge count (ABRC) among the male and female E-β-thalassemia patients

Patients	Male Mean±SD	Female Mean±SD
Right hand	53.23±10.34*	44.86±5.82
Left hand	53.89±11.29	51.78±8.19*
Both hands (TABRC)	53.56±10.75*	48.31±7.87

*p<0.05

Table 2: Distribution of a-b ridge count (ABRC) among the male and female controls

Controls	Male Mean±SD	Female Mean±SD
Right hand	44.11±7.34	41.63±6.71
Left hand	43.69±6.35	42.23±6.12
Both hands (TABRC)	43.90±6.81	41.93±6.38

DISCUSSION

The relationship between bone dimension and dermal ridge patterns has been subject matter of many studies (Abel 1938; Babler 1987). E-β thalassemia has the pleiotropic effect on bone dimension due to abnormal haemopoiesis occurs in the bone marrow. The bone histomorphometry of thalassemia revealed increased osteoid thickness and delayed osteoid maturation and mineralization, indicating impaired bone matrix maturation and defective mineralization (Mahachoklertwattana *et al.,* 2003). Therefore, the dermatoglyphic features of thalassemia could have association due to impaired bone dimensions. In this circumstance, the present study revealed significantly ($p<0.05$) higher a-b ridge count among the E-β thalassemia patients (Table 3) in comparison to the controls, which is corroborative with earlier studies on the thalassemia patients (Bhalla *et al.,* 2004; Andani *et al.,* 2012).

Moreover, significant ($p<0.05$) sexual dimorphism (Table 1) with regard to increased a-b ridge count among the male E-β thalassemia patients might be of special interest and needs further elucidation and study on twins (Van Oel *et al.,* 2001) delineated that the a-b ridge count in males was more influenced by environmental factors than the other count. However, the present study

also revealed a trend of higher a-b ridge count among the control males in comparison to that of the females (Table 2).

Table 3: Distribution of a-b ridge count (ABRC) among E-β-thalassemia patients and controls

	Patients Mean±SD	**Controls Mean±SD**
Right hand	49.04±9.33*	42.87±7.09
Left hand	52.83±9.85*	42.96±6.23
Both hands (TABRC)	50.94 ±9.75*	42.91±6.65

*p<0.05

Since, dermatoglyphics may be affected by both genetic and environmental factors, therefore, a relationship exists between embryonic stress and distortion of dermatoglyphic patterns and various developmental abnormalities caused by gene and / or chromosome deficiency, environmental pressure or a combination of causes. This overall effect might affect dermatoglyphic features by disrupting the two sided (bilateral) symmetry of the affected condition (Kobyliansky *et al.,* 2006).

The presence of significant ($p<0.05$) bilateral asymmetry among the female patients due to the higher value of ABRC on their left hand, might be due to adverse intrauterine experience in E-β thalassemia patients. The reasons could be specifically, simplification, ridge dissociation, abnormal features, and bilateral asymmetry of dermatoglyphics and genetic, environmental and multifactorial instability impair the developmental homeostasis of individuals and act to enhance their level of bilateral asymmetry (Livshits and Kobyliansky 1991).

The present study is in consistency with earlier report (Andani *et al.,* 2012) regarding bilateral asymmetry in terms of significantly increased ABRC in right hand among the thalassemia major patients but the study lacked the gender specificity. Thalassemia being one of the major blood disorder and having pleiotropic effect on skeletal conditions might influence the dermatoglyphic features distinctively in dermatoglyphic ridge counts. Studies revealed growth retardation due to skeletal deformities originated from genetic, hormonal and nutritional deficits are concomitant regulatory factors among the thalassemia patients (Perrotta *et al.,* 2000; Karamifar *et al.,* 2008; Kumari *et al.,* 2012; Perisano *et al.,* 2012). Furthermore, studies revealed that ridges are

influenced by blood vessel-nerve pairs at the border between the dermis and epidermis during prenatal development (Kahn *et al.,* 2008) and probable influencing factors to ridge pattern might be inadequate oxygen supply, unusual distribution of sweat glands and alterations of epithelial growths (Schaumann and Alter 1976). Thus the findings of the present study specifically the significantly ($p<0.05$) increased ABRC and TABRC as well might be due to the relationship of skeletal deformities among the thalassemia patients. Nevertheless, ridge count has proved a suitable quantitative trait for genetic analysis (Bonnevie 1924) and a-b ridge count is more sensitive than the other dermatoglyphic traits as the second interdigital area where the a-b ridge count is situated begins to develop earlier than the fingers (Rose *et al.,* 1987). However ridge formation progresses more slowly on the palms than the fingers and ridge differentiation proceeds in a distal radial to proximal ulnar direction. Thus the ridges in the second interdigital region may develop over a longer period, exposing the area for a longer period to potential environmental stresses (Fearon *et al.,* 2001). In corroboration, the present study also revealed increased second interdigital area in the form of increased ABRC among the E-β thalassemia might be due exposure of potential environmental stresses for abnormal haemopoiesis and thereby, increased osteoid thickness and delayed osteoid maturation (Mahachoklertwattana *et al.,* 2003).

Currently several dermatoglyphic researches claim a high degree of accuracy in prognostic ability of different dermatoglyphic traits mainly the ridge counts (Keith 2004). Regarding the a-b ridge count differential results have been reported. For example, in schizophrenia (Turek 1990; Fananas *et al.,* 1996; Davis and Bracha 1996; Fearon *et al.,* 2001; Bramon *et al.,* 2005) and albinism (Ghodsi *et al.,* 2012) a-b ridge count was found to be decreased. On the other hand, increased value for a-b ridge count was observed among the patients with epilepsy (Lal and Sureka 2012), diabetes mellitus (Rakate and Zambare 2013) and thalassemia (Bhalla *et al.,* 2004; Andani *et al.,* 2012). Eventually, not only the a-b ridge count (ABRC) of the right and left hand separately, but total a-b ridge count (TABRC) of both the hands have been reported as better predictor for palmar ridge differences among the patients with myocardial infarction (Manara *et al.,* 2011), schizophrenia (Saha *et al.,* 2003) and diabetes (Nezhad and Shah 2010). In this context, the present study also demonstrated that TABRC of both the hands of the E-β thalassemia patients revealed significant ($p<0.05$) increase of a-b ridge count compared to the controls. Therefore, the present study envisaged the potential value of dermatoglyphic traits as

one of the non-invasive technique, in clinical medicine and as well as valuable aid for clinical diagnosis pertaining to the association of increased ABRC and TABRC as a risk factor for of E-β thalassemia and could be useful for early prognosis of E-β thalassemia.

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