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Haemoglobin Variants in North Indian Populations

S.M.S. Chahal and Rupinder Bansal

Proteomic Laboratory, Department of Human Biology, Punjabi University, Patiala 147 002, Punjab, India
E-mail: smschahal@rediffmail.com

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ABSTRACT Original data are presented on haemoglobin variants among 96 regional endogamous tribal and non-tribal population groups of North India inhabiting four states of Himachal Pradesh, Uttaranchal, Punjab and Haryana. For this work a total of 13,518 haemolysates were screened in conjunction with routine typing of the red cell enzyme glyoxalase I (GLO I) in several different biochemical genetics investigations carried out by our laboratory over the last almost two decades. As for the incidence of haemoglobin variants (HB AV) it was found to be variable – from 0.7% in Himachal Pradesh and 0.9% in Uttaranchal to 1% in Punjab and 1.1% in Haryana, suggesting a South- North decreasing cline. The overall HB AV incidence for people of North India was recorded 0.9%. An interesting finding of the present study was the discovery of very high frequency of haemoglobin variants, in polymorphic proportions (4.5 – 9.5%) in two tribal groups of Uttaranchal viz., the Tharu and Bhoksa. Importance of haemoglobin as a useful genetic marker in Indian context has been emphasized.

INTRODUCTION

Haemoglobin, HB the red respiratory protein found in mammalian erythrocytes is one of the most informative molecules in primate blood. It is a tetramer that consists of two α-like and two β-like globin subunits. The abnormal haemoglobins differ from normal haemoglobins in molecular structure. They have structure similar to that of normal haemoglobin except slight alteration in the sequence of amino acids (usually in the β-chain) and hence may be designated as mutant or variant haemoglobins.

The term haemoglobinopathies covers a group of hereditary abnormalities in which the structure (like HB S, C, D, E) or the rate of synthesis (thalassaemia) of one of the normal haemoglobin chain is altered. A review of literature reveals that most of the data available on haemoglobins among North Indian populations are based on sickling test (Bhasin et al., 1992); Singh et al., 1994). However, it may be pointed out that this test detects only sickle cell trait (HB AS), while the technique of electrophoresis reveals the presence of this as well as all other types of haemoglobin variants. Therefore to find out the true incidence of haemoglobin variants in a population electro-phoresis is the technique of choice and studies in all parts of the country are urgently required to assess their frequency. This is especially so since like any other tropical country of the world, India is a "great reservoir for abnormal haemoglobins" (Saha and Banerjee, 1971).

It may also be pointed out that most of earlier studies on haemoglobin reported were case studies and reports from hospitals, and since samples studied were heterogeneous, they cannot be regarded to represent any specific population. Biogenetic studies should be based on well defined populations, both ethnically and geographically. In this direction, first attempt was made by Chahal et al. (1999) who provided haemoglobin variant data on people of Punjab. The aim of this communication is to present some additional data from north of Punjab, as well as to provide such new information on various tribal/ non-tribal populations of neighbouring states of Himachal Pradesh, Uttaranchal and Haryana. This would help in constructing sructural haemoglobinopathies national database for people of North India, employing electrophoretic techniques.

MATERIAL AND METHODS

This study is based on electrophoretic typing of haemolysates from a total of 13,518 subjects belonging to as many as 96 regional endogamous caste/tribal population groups of North India inhabiting the states of Himachal Pradesh (n =3196), Uttaranchal (n = 3643), Punjab (n = 4462 including 3401 reported earlier by Chahal et al., 1999) and Haryana (n = 2217).

In a pioneer observation Divall and Greenhalgh (1983) demonstrated that blood samples can be screened effectively for the common

haemoglobin variants (HB AS, AC, AD and AE) in conjunction with erythrocyte enzyme glyoxylase I (GLO I) typing and only variants so detected be further identified, if required. Following this method, in the present investigation, agarose/starch gel electrophoresis plates for GLO I typing (Chahal et al., 1986) were examined for haemoglobin variants after the completion of the run, just before staining them for the detection of the enzyme. In majority of the cases, a single banded slow moving cathodal pattern was observed and characterized as 'normal' haemoglobin HB A pattern. In some cases a double banded pattern, one of which had same electrophoretic mobility as the 'normal' pattern and anotherb and having a faster mobility towards cathode, band was found and referred to as a 'variant' haemoglobin pattern HB AV. Occasionally only a single fast moving band, representing homozygous variant pattern, was also encountered . In this study no attempt was made to characterize the variants observed.

RESULTS AND DISCUSSION

Results are presented in Table 1 which shows that almost one out of two population groups studied here from North India recorded the presence of variant type of haemoglobin. However, statewise, 11 out of 23 (48%) studied groups of Himachal Pradesh, 10 out of 29 (34%) of Uttaranchal, 18 out of 30 (60%) of Punjab and 10 out of 14 (71%) of Haryana had shown the presence of haemoglobin variants. As for the frequency of HB AV variant the value was found to be 0.7% in Himachal Pradesh, 0.9% in Uttaranchal, 1% in Punjab and 1.1% in Haryana, yielding an overall estimate of 0.9% for people of North India. Thus this study indicates interstate differentials in the distribution of this genetic marker and provides evidence for a slight South-North decreasing cline in the incidence of haemoglobin variants in North Indian states.

In the hill state of Himachal Pradesh, northern district of Kulu falling in the Main (Great) Himalayan physiographic zone (Negi, 1993) revealed a complete absence of any haemoglobin variant (HB AV). On the other hand, each of the remaining eight southern districts considered here recorded its presence. The twin districts of Shimla and Solan showed the highest incidence of HB AV in Himachal Pradesh, followed by Hamirpur and Bilaspur districts while Sirmaur and Una districts showed the least incidence. All these districts fall in the Outer (Siwalik) and Lower (Lesser) Himalayan physiographic zones.

Thus it is interesting to note that in Himachal Pradesh haemoglobin variants are more frequent in the southern districts of the state which are contiguous with the plains of adjoining states of Punjab and Haryana. This may be attributed to less hilly terrain of these districts conducive for mosquito growth and propagation of malarial, which acts as a selective agents in human populations (Fix, 2003). However, the occurrence of this trait in Shimla and Mandi districts, lying in the interiors is intriguing and calls for some other explanations such as tourist inflow from the plains to these areas.

Similarly, all populations inhabiting northern mountainous districts of Uttarkashi and Dehradun in the neighbouring hill state of Uttaranchal also lacked any haemoglobin (HB AV) variant while in each of the remaining three districts of Garhwal region as well as all four districts of southern Kumaon region, the trait was encountered. Apparently, the average incidence of haemoglobin variants in Uttaranchal is somewhat higher (0.9%) compared to the value recorded in Himachal Pradesh (0.7%). However, the estimate in the former state becomes much lower (0.3%) than the latter if two tribal samples of the Tharu and Bhoksa are disregarded. Thus, in reality this newly carved out hill state has the lowest frequency of haemoglobin variants in the entire North Indian sample considered here.

The incidence of haemoglobin variant (HB AV) found in the Tharu (4.5%) and Bhoksa (9.5%) tribal groups inhabiting foothill area of Udham Singh Nagar district of Uttaranchal are very high indeed by any standard and calls for an explanation, especially when two other tribes from highland areas of the state viz., the Jaunsari and Bhotia lacked any haemoglobin variant. The Terai (foothill) area which the Tharu and Bhoksa tribes inhabit has a known history of hyperendemic malaria. Since heterozygous sickle cell trait carriers (HB AS)/(HB AV) are probably resistant to malaria than normal homozygotes (HB A) the present findings corroborate the hypothesis proposed by Cavalli-Sforza and Bodmer (1971).

In comparison to Himachal Pradesh and Uttaranchal, in two North Indian states of Punjab and Haryana falling in the Indo-Gangetic plains,

Table 1: Haemoglobin (Hb) types detected electrophoretically in various caste and tribal population groups of North India.

Area	*Population*	*Number tested*	*Hb phenotypes*		*Hb allele frequencies*		*Reference*
			A	*AV*	*Hb*A*	*Hb*V*	
NORTH INDIA							
Himachal Pradesh							
Kulu District							
	Brahmin	114	114	0	1.0000	0.0000	Present study
	Rajput	234	234	0	1.0000	0.0000	Present study
	Koli (SC)	101	101	0	1.0000	0.0000	Present study
Chamba District							
	Brahmin	195	195	0	1.0000	0.0000	Present study
	Rajput	76	76	0	1.0000	0.0000	Present study
	Chamba town						
	Brahmin	72	72	0	1.0000	0.0000	Present study
	Rajput	112	112	0	1.0000	0.0000	Present study
	Khatri	79	77	2 (2.5)	0.9873	0.0127	Present study
	Mahajan	63	63	0	1.0000	0.0000	Present study
Shimla District							
	Brahmin	111	108	3 (2.7)	0.9865	0.0135	Present study
	Rajput	191	189	2 (1.0)	0.9948	0.0052	Present study
Solan District							
	Brahmin	142	141	1 (0.7)	0.9965	0.0035	Present study
	Rajput	160	154	6 (3.8)	0.9812	0.0188	Present study
	Sirmaur district						
	Brahmin	156	156	0	1.0000	0.0000	Present study
	Rajput	162	161	1 (0.6)	0.9969	0.0031	Present study
Mandi District							
	Brahmin	156	155	1 (0.6)	0.9968	0.0032	Present study
	Rajput	153	153	0	1.0000	0.0000	Present study
Bilaspur District							
	Brahmin	154	152	2 (1.3)	0.9935	0.0065	Present study
	Rajput	160	160	0	1.0000	0.0000	Present study
Hamirpur District							
	Brahmin	150	147	3**(2.0)	0.9867	0.0133	Present study
	Rajput	151	150	1 (0.7)	0.9967	0.0033	Present study
Una District							
	Brahmin	164	163	1 (0.6)	0.9970	0.0030	Present study
	Rajput	140	140	0	1.0000	0.0000	Present study
Total Himachal Pradesh		**3196**	**3173**	**23 (0.7)**	**0.9962**	**0.0038**	
Uttaranchal							
Uttarkashi District							
	Brahmin	116	116	0	1.0000	0.0000	Present study
	Rajput	200	200	0	1.0000	0.0000	Present study
	Dom (SC)	45	45	0	1.0000	0.0000	Present study
	Bhotia (ST)	97	97	0	1.0000	0.0000	Present study
Dehradun District							
	Jaunsari Brahmin (ST)	54	54	0	1.0000	0.0000	Present study
	Jaunsari Rajput (ST)	285	285	0	1.0000	0.0000	Present study
	Jaunsari (others) (ST)	83	83	0	1.0000	0.0000	Present study
Tehri District							
	Brahmin	144	143	1 (0.7)	0.9965	0.0035	Present study
	Rajput	188	188	0	1.0000	0.0000	Present study
	Dom (SC)	22	22	0	1.0000	0.0000	Present study

Table 1: Contd...

Area	*Population*	*Number tested*	*Hb phenotypes*		*Hb allele frequencies*		*Reference*
			A	*AV*	*Hb*A*	*Hb*V*	
Pauri District							
	Brahmin	106	105	1 (0.9)	0.9953	0.0047	Present study
	Rajput	149	149	0	1.0000	0.0000	Present study
	Dom (SC)	9	9	0	1.0000	0.0000	Present study
Chamoli District							
	Brahmin	120	119	1 (0.8)	0.9958	0.0042	Present study
	Rajput	201	201	0	1.0000	0.0000	Present study
	Dom (SC)	30	30	0	1.0000	0.0000	Present study
	Bhotia (ST)	127	127	0	1.0000	0.0000	Present study
Nainital District							
	Brahmin	195	193	2 (1.0)	0.9949	0.0051	Present study
	Rajput	156	156	0	1.0000	0.0000	Present study
	Dom (SC)	70	70	0	1.0000	0.0000	Present study
Udham Singh Nagar District							
	Tharu (ST)	200	191	9** (4.5)	0.9750	0.0250	Present study
	Bhoksa (ST)	168	152	16** (9.5)	0.9494	0.0506	Present study
Almora District							
	Brahmin	163	162	1 (0.6)	0.9969	0.0031	Present study
	Rajput	170	170	0	1.0000	0.0000	Present study
	Dom (SC)	82	82	0	1.0000	0.0000	Present study
Pithoragarh District							
	Brahmin	128	127	1 (0.8)	0.9961	0.0039	Present study
	Rajput	125	123	2 (1.6)	0.9920	0.0080	Present study
	Dom (SC)	79	79	0	1.0000	0.0000	Present study
	Bhotia (ST)	131	131	0	1.0000	0.0000	Present study
Total Uttaranchal		**3643**	**3609**	**34 (0.9)**	**0.9953**	**0.0047**	
Punjab							
Gurdaspur District							
	Jat Sikh	176	173	3 (1.7)	0.9915	0.0085	Present study
Amritsar District							
	Jat Sikh	181	180	1 (0.6)	0.9972	0.0028	Present study
Hoshiarpur District							
	Jat Sikh	172	171	1 (0.6)	0.9971	0.0029	Present study
Kapurthala District							
	Jat Sikh	180	180	0	1.0000	0.0000	Present study
Jalandhar District							
	Jat Sikh	177	177	0	1.0000	0.0000	Present study
Nawanshahar District							
	Jat Sikh	175	174	1 (0.6)	0.9971	0.0029	Present study
Ferozepur District							
	Jat Sikh	140	140	0	1.0000	0.0000	Chahal et al., 1999
	Ramdasia (SC)	86	86	0	1.0000	0.0000	Chahal et al., 1999
	Mazhabi (SC)	114	111	3 (2.6)	0.9868	0.0132	Chahal et al., 1999
Mukatsar District							
	Jat Sikh	141	137	4 (2.8)	0.9858	0.0142	Chahal et al., 1999
	Ramdasia (SC)	82	80	2 (2.4)	0.9878	0.0122	Chahal et al., 1999
	Mazhabi (SC)	123	121	2 (1.6)	0.9919	0.0081	Chahal et al., 1999
Bathinda District							
	Jat Sikh	157	156	1 (0.6)	0.9968	0.0032	Chahal et al., 1999
	Ramdasia (SC)	103	103	0	1.0000	0.0000	Chahal et al., 1999
	Mazhabi (SC)	96	96	0	1.0000	0.0000	Chahal et al., 1999
Sangrur District							
	Jat Sikh	164	160	4 (2.4)	0.9878	0.0122	Chahal et al., 1999
	Ramdasia (SC)	119	119	0	1.0000	0.0000	Chahal et al., 1999
	Mazhabi (SC)	92	89	3 (3.3)	0.9837	0.0163	Chahal et al., 1999
	Sunni Muslim	803	793	10 (1.2)	0.9938	0.0062	Chahal et al., 1999
	Shia Muslim	189	188	1 (0.5)	0.9974	0.0026	Chahal et al., 1999

Contd... Table 1.

Area	*Population*	*Number tested*	*Hb phenotypes*		*Hb allele frequencies*		*Reference*
			A	*AV*	*Hb*A*	*Hb*V*	
Rupnagar District							
	Jat Sikh	168	168	0	1.0000	0.0000	Chahal et al., 1999
	Ramdasia (SC)	127	125	2 (1.6)	0.9921	0.0079	Chahal et al., 1999
	Mazhabi (SC)	76	76	0	1.0000	0.0000	Chahal et al., 1999
Patiala District							
	Jat Sikh	54	53	1 (1.9)	0.9907	0.0093	Chahal et al., 1999
	Kamboh	170	170	0	1.0000	0.0000	Chahal et al., 1999
	Brahmin	82	82	0	1.0000	0.0000	Chahal et al., 1999
	Khatri	143	139	4 (2.8)	0.9860	0.0140	Chahal et al., 1999
	Bania	110	109	1 (0.9)	0.9955	0.0045	Chahal et al., 1999
	Ramgarhia Sikh	21	20	1 (4.6)	0.9762	0.0238	Chahal et al., 1999
	Ramdasia (SC)	41	40	1 (2.5)	0.9878	0.0122	Chahal et al., 1999
Total Punjab	**4462**	**4416**	**46(1.0)**	**0.9948**	**0.0052**		
Haryana							
Kurukshetra, Hisar, Jind and Mahendragarh Districts							
	Jat	210	208	2 (1.0)	0.9952	0.0048	Present study
Mahendragarh District							
	Ahir	208	207	1 (0.5)	0.9976	0.0024	Present study
Kurukshetra District							
	Ror	201	200	1 (0.5)	0.9975	0.0025	Present study
	Brahmin	111	110	1 (0.9)	0.9955	0.0045	Present study
	Bania	119	119	0	1.0000	0.0000	Present study
	Rajput	113	112	1 (0.9)	0.9956	0.0044	Present study
	Balmiki (SC)	106	106	0	1.0000	0.0000	Present study
	Khatik (SC)	128	127	1 (0.8)	0.9956	0.0044	Present study
	Jheenvar	108	101	7 (6.5)	0.9676	0.0324	Present study
Kurukshetra and Mahendragarh Districts							
	Saini	200	197	3 (1.5)	0.9925	0.0075	Present study
Yamunanagar and Sirsa Districts							
	Kamboj	199	199	0	1.0000	0.0000	Present study
Sirsa District							
	Kumhar	204	202	2 (1.0)	0.9951	0.0049	Present study
Kurukshetra, Sirsa, Hisar and Mahendragarh Districts							
	Chamar (SC)	200	195	5 (2.5)	0.9875	0.0125	Present study
Karnal District							
	Sansi (SC)	110	110	0	1.0000	0.0000	Present study
Total Haryana		**2217**	**2193**	**24 (1.1)**	**0.9946**	**0.0054**	
Total North India		**13518**	**13391**	**127*** (0.9)**	**0.9952**	**0.0048**	

Figures in parantheses are percentages
SC = Scheduled Caste ST = Scheduled Tribe
** Include one rare homozygote variant
*** Include three rare homozygote variants

the incidence of haemoglobin variants (HB AV) was comparatively higher. This again may be attributed to a comparatively high occurrence of malaria in the plains than in the hills. In Punjab, barring Kapurthala, Jallandhar and Ferozepur, populations of all other districts showed the presence of haemoglobin variants; the average incidence of HB AV comes out to be 1.0%, a figure close to an earlier estimate of 1.2% from the state (Chahal et al., 1999). Like in Punjab, in Haryana also almost all districts showed the presence of haemoglobin variants, and the average value (1.1%) was very close to the estimate of its neighbouring northern state.

Pooling together the data from the four states of this study yields a figure of 0.9% for the occurrence of haemoglobin variants (HB AV) in people of North India. However, as noted earlier there are certain intra-state differences in the incidence of HB AV and the fact that populations of both

Himachal Pradesh and Uttaranchal have shown consistently lower values compared to that of Punjab and Haryana. This points to genetic heterogeneity in the distribution of haemoglobin variants (HB AV) in different states of North India situated in the hills and the plains of the region.

Thus, the present study has firmly placed North Indian states of Himachal Pradesh, Uttaranchal, Punjab and Haryana on the haemoglobinopathies map of India, since early data was scanty. Furthermore, the present investigation once again demonstrates the usefulness of blood protein haemoglobin in studying genetic variation among different tribal and non-tribal populations inhabiting a geographical region. This genetic marker certainly has much potential in anthropological investigations in a tropical country like India and therefore in all future biogenetic surveys from the country it should be routinely included.

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REFERENCES

Bhasin, M.K., Walter, H., Danker-Hopfe, H.: *The Distribution of Genetical, Morphological and Behavioural Traits Among The Peoples of Indian Region.* Kamla-*R*aj Enterprises, Delhi (1992).

Cavalli-Sforza, L.L and Bodmer, W.F.: *The Genetics of Human Populations*. Freeman, San Francisco (1971).

Chahal, S.M.S., Kaur, H.P., Virk, R.K. and Singh, H.: Screening for haemoglobin variants in people of Punjab, North-West India. *J. Hum. Ecol*. **10:** 435-438 (1999).

Chahal, S.M.S., Sehgal, I.K., Bansal, I.J.S. and Singh, P.: Population genetics of glyoxalase I (GLO I) polymorphism in India. *Anthrop. Anz*., **44:** 249-256 (1986).

Divall, G.B. and Greenhalgh, M.: The screening of blood samples for haemoglobin variation in conjunction with glyoxalase typing. *J. Forens. Sci. Soc*., **23**: 49-51 (1983).

Fix, A.G.: Simulating hemoglobin history. *Hum. Biol*. **75:** 607-618 (2003).

Negi, S.S.: *Himachal Pradesh: The Land and People.* Indus Publishing Company, New Delhi (1993).

Saha, N. and Banerjee, B.: Incidence of abnormal haemoglobins in different ethnic groups of Indians. *Humangenetik*, **11**: 300-303 (1971).

Singh, K.S., Bhalla, V. and Kaul, V.: *The Biological Variation in Indian Populations. People of India. National Series Volume X*. Anthropological Survey of India/ Oxford University Press, Delhi (1994).