Radiology of Sickle Cell Anemia

THESIS

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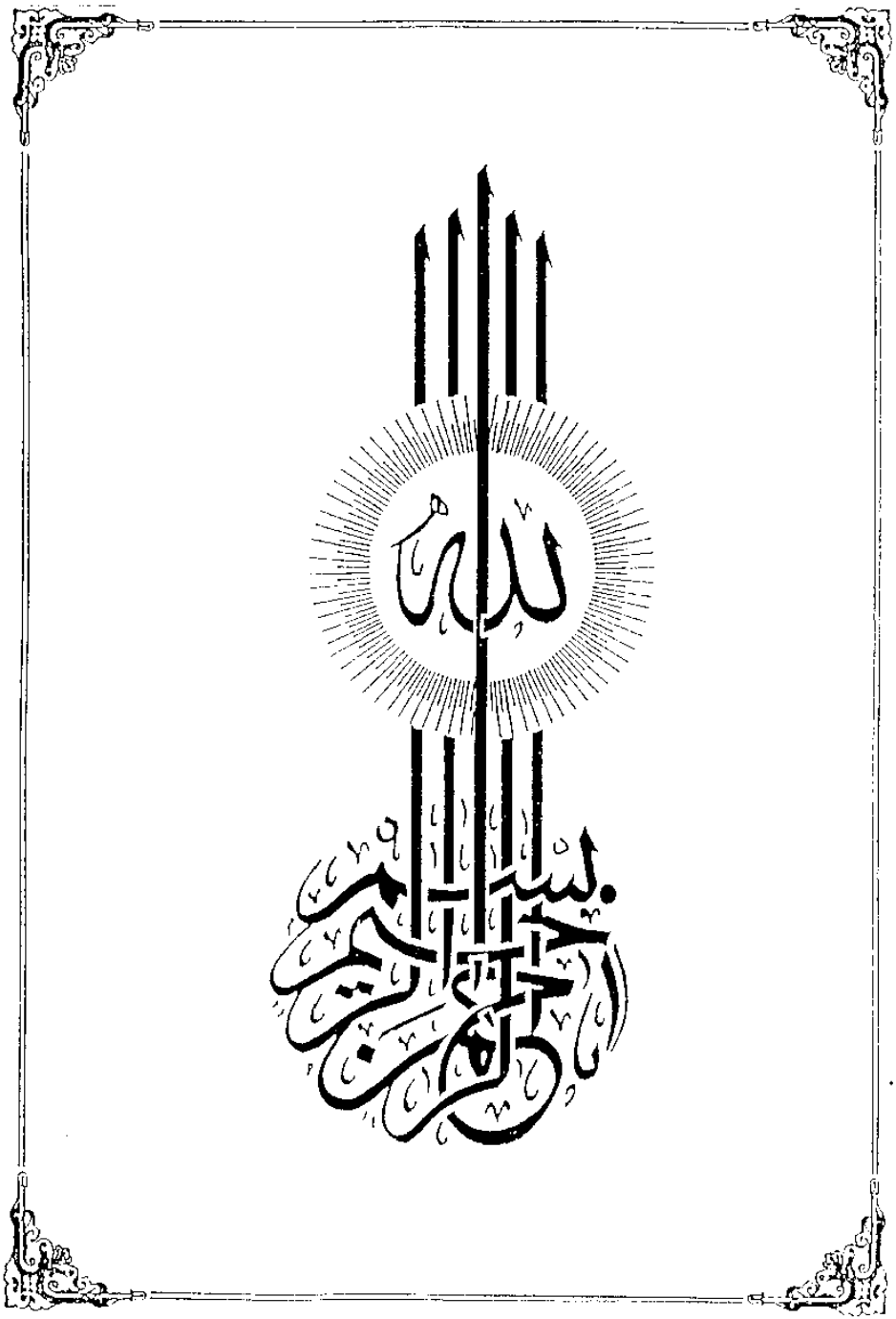

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RADIOLOGY OF SICKLE CELL ANEMIA

Introduction and aim of the work

Sickle cell anemia is one type of the chronic hemolytic anemias which is congenital, heritable and lethal It is a qualitative type of hemoglobinopathies which is characterised by the presence of red blood cells that assume sickle or oat shapes under hypoxic conditions due to the formation of abnormal hemoglobin (Hemoglobin S) inside the cells . With the development of recent laboratory techniques a considerable advance in explaining the genetic , pathologic and clinical aspects of this disease has been realised.

The present work was undertaken to establish the diverse radiological changes caused by sickle cell anemia in different body systems and to emphasise the role of radiology in diagnosis of sickle cell anemia

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Etiology

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(II): Etiology

The cause is a mandelian dominant, mutant gene(B^S gene) which results in the synthesis of abnormal hemoglobin (Hb.s) (Neel. J.V, 1951).

Individuals with sickle cell anemia are those individuals who have inherited the sickle cell gene from both parents (i.e homozygous).

Homozygotes possess a pair of mutant genes and essentially all of their hemoglobin is abnormal (Hb.S).

Normally, at birth, about 60-80% of the respiratory blood pigment is foetal hemoglobin (Hb.F)

None of Hb.F is formed after birth. By the age of 6 months, Hb.F decreases to the normal adult levels of less than 2% (Huisman, 1 972)., and is replaced by the normal adult hemoglobin (Hb.A). The predominant normal human hemoglobin (Hb.A) contains two types of globin chains designated by the greek lettres α & B

Each chain begins with an N-terminal raline group and neither is branched .(see figures 1,2)

The α - chains are comprised of 141 amino-acids while the B-chains are comprised of 146 amino-acids. Each molecule of Hb.A has two α - chains and two B- chains.

In sickle cell anemia, there is replacement of glutamic acid by valine at position 6 at the N-terminal end of

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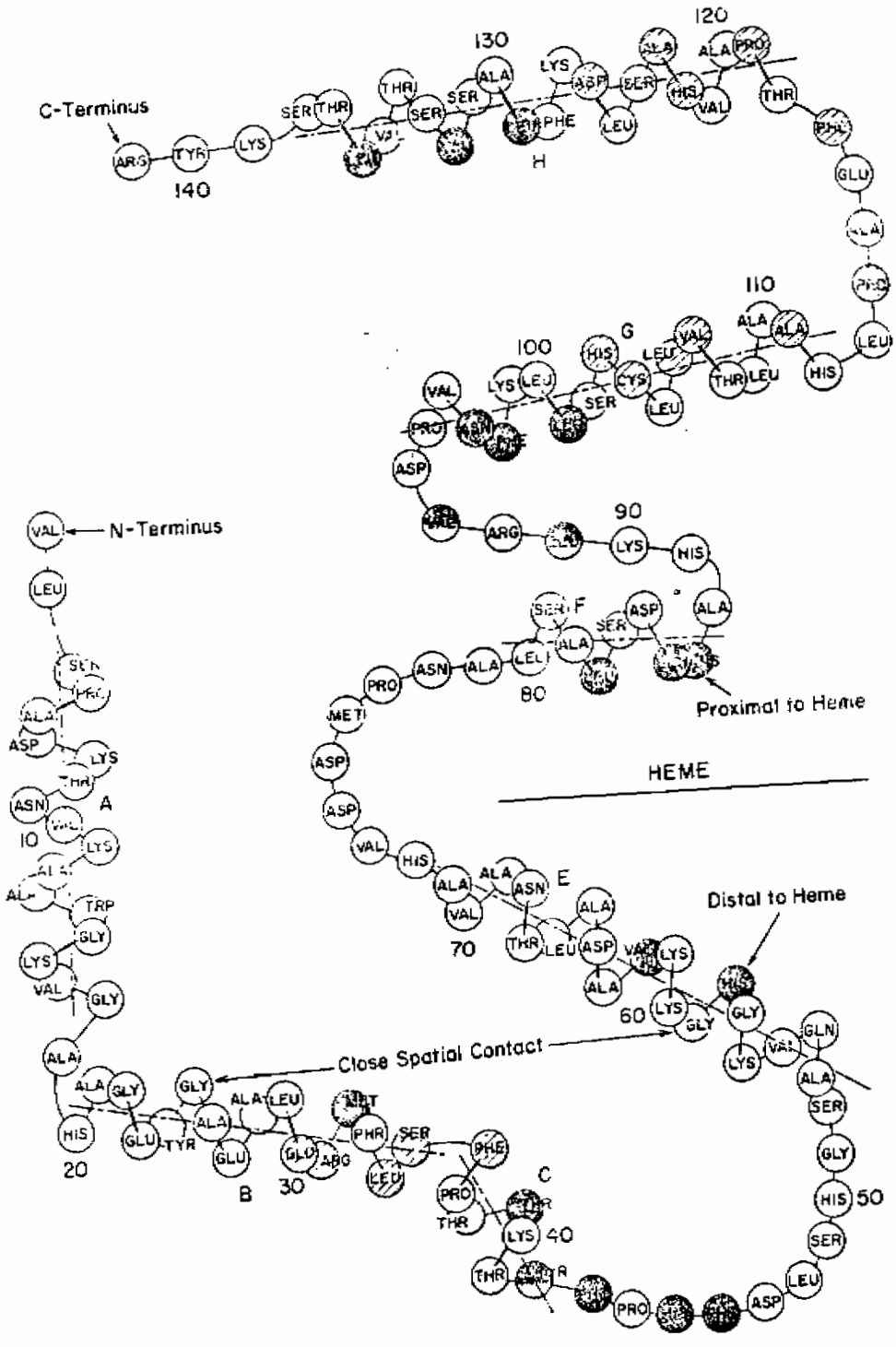

Hb. A

Quoted from Hematology : Physiologic pathophysiologic and Clinical principle by (James N. Linman, 1975).

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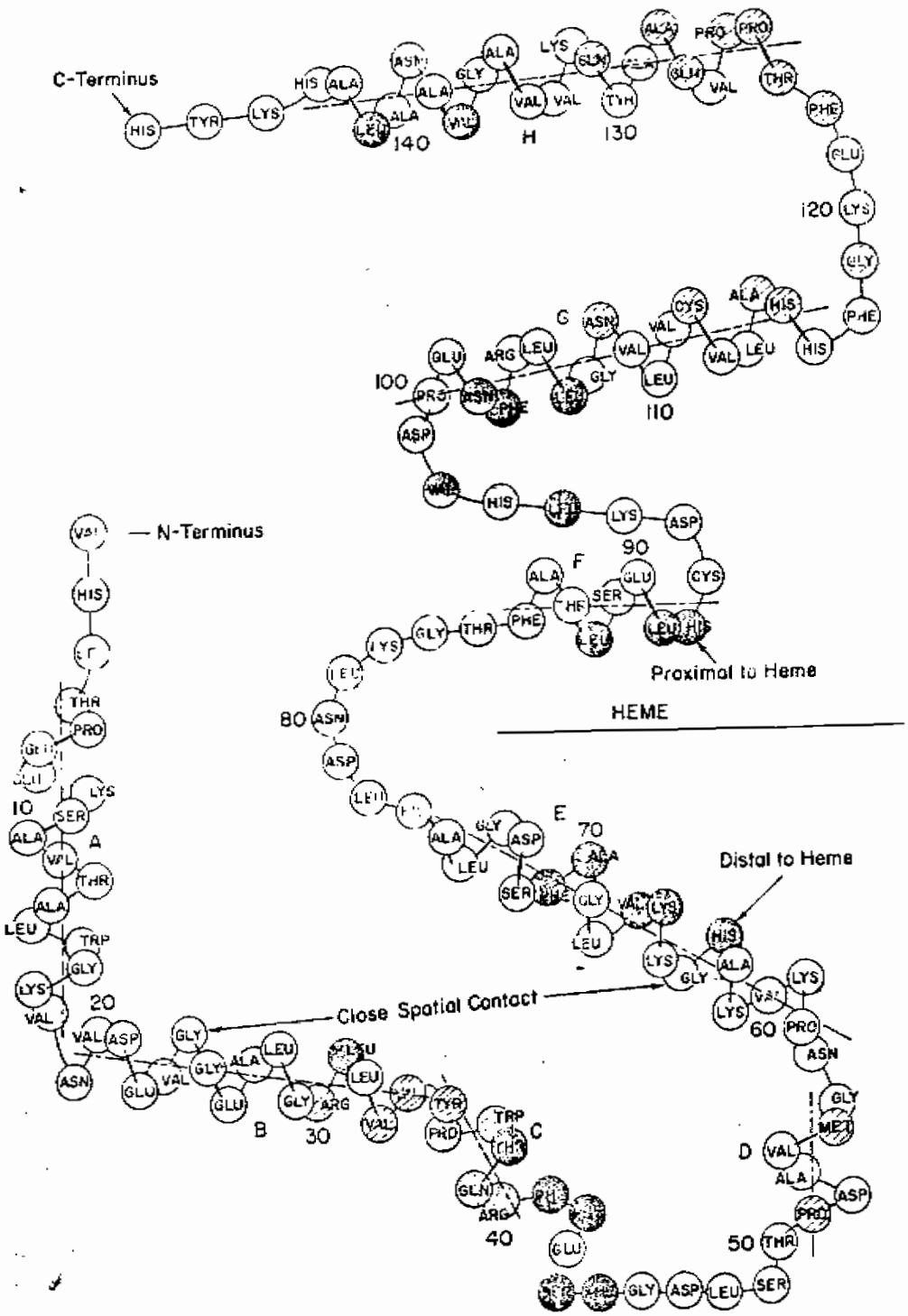

Hb.B

Quoted from Hematology: Physiologic pathophysiologic and Clinical principle by

(James. N. Linman, 1975).

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B- chain (Linman J.N., 1975).

N.B. if only one parent possess the abnormal hemoglobin (Hb.S) and the other have the normal hemoglobin (Hb.A) the offspring (heterozygous) will have only the sickle cell trait where the concentration of Hb.S in the erythrocytes with a single B^{-S} gene is so low (20 - 40%) that sickling does not occur at the physiologic oxygen tensions. Symptomatic forms of this hemoglobinopathy also occur when a single sgene is inherited in combination with the gene for another abnormal hemoglobin such as S- thalassema (S-thal) or Hb.C(SC).

Incidence

Sickle cell anemia is found almost exclusively in Negroes and in those who are part of *Negro* ancestry. Approximately one in 600 American Negroes has sickle cell anemia. The disorder predominates among . East and West Africa tribes and is present to a lesser extent among South Africa Bantus and the Negro peoples from the West Indies and North, central and South America.

Rarely, it is found in certain aboriginal groups of Southern India, Arabia Greece and Southern Turkey. (Gelpi & Perrine, 1973)

The responsible mutant gene (B.S gene) propably originated in Africa although it may have been carried there in neolithic times by peoples migrating from Arabia (Howard. L. Steinbach, et al 1975).

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Pathology & Pathogenesis

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Pathophysiology & Pathogenesis

Sickle cell anemia is a striking example of a complex diverse manifestations that can be explained on a single molecular basis (lessin & Jensen, 1974).

All the manifestations of sickling phenomenon can be explained by the unique property of Hb.S to be transformed into a viscus, semisolid gel under a variety of physiologic conditions (Murayama, 1967).

The physiologic factors affecting sickling include

1- Oxygen tension

* Oxygen tension determines sickling in vivo (Serjeant et al., 1973).
* The deoxygenated form of Hb.S is much less soluble than the deoxygenated Hb.A and forms tactoids " paracrystalline aggregates " , consequent to attraction and resultant parallel chains of hemoglobin polymers.
* Electron microscopy " E/M " has revealed these tactoids to consist of cable-like structures resembling microtubules (Bessis and Dobler, 1970).
* These changes are reversible on reoxygenation, (Padilla et al., 1973), and constitute the architectural basis for the

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formation of sickle cell; the hall mark of the disease.

2- Sickle cell formation is primarily dependent on the *amount of Hb.S* in the erythrocyte. (Seakins et al., 1973). In individuals with sickle cell trait (one B^S gcue), the concentration of Hb.S is so low (20-40%) that sickling does not occur at physiologic oxygen tension.

3- Other factors affecting sickling phenomenon include: Ph , urea , osmolarity and types of Hb other than Hb.S present in the cell:-

a): Low pH enhances sickle cell formation (Greenberg et al., 1957).

b): Urea inhibits sickling, presumably by interrupting hydrophobic interactions (Nalbandian et al., 1961)

c): Hyperosmolarity also contributes to sickling and appears to play an important role in renal manifestations of Hb.S disease.

d): Hemoglobin. F. will enter in molecular aggregates or polymer formation with Hb.S , as will Hb.A and Hb.C. therefore Hb.F protects an erythrocyte against sickling formation. Thirty percent (30%) Hb.F.will prevent sickle formation (Bertles et al., 1970).

For this reason, sickle cell anemia is not evident at birth (60 - 80% of a newborn infant's hemoglobin is Hb.F) and

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