



## Breakthrough in Radiographic Imaging in Appropriation of Relevant Diagnosis of Thalassemia

\*Dr. Parveen Chandna<sup>1</sup>, Dr. Jeevika M.U.<sup>1</sup>, Dr. Siddesh M.B.<sup>1</sup>,  
Dr. Shees Ismail Kazia<sup>2</sup>, Dr. K. Rajesh Reddy<sup>2</sup>

<sup>1</sup>Department Of Radio-Diagnosis, J.J.M. Medical College, Davangere, Karnataka, India

<sup>2</sup>Department Of Pediatrics, J.J.M. Medical College, Davangere, Karnataka, India

Received; 27 Jan. 2017 Accepted; 18 Feb. 2017; © The author(s) 2017. Published with open access at [www.questjournals.org](http://www.questjournals.org)

**ABSTRACT:** Now-a-days, Thalassemia (Cooley's anemia, Mediterranean anaemia) – the most common type of hereditary disorder is posing a serious threat in this existing world. In untreated thalassemia, the skeletal ineffectiveness has been noticed as a result of distorted bone marrow, consequently proving deleterious to each and every part of the skeleton. Major alterations have been found to be detrimental and severe enough resulting in growth retardation, osteoporosis, kyphosis and platyspondyly. Inadequate imaging as a consequence of abundance of bone marrow mimics haematopoiesis.

In  $\alpha$ -thalassemia, functional disorder of the  $\alpha$ -globin component of hemoglobin synthesis is duly defective, but in  $\beta$ -thalassemia, the  $\beta$ -globin component of hemoglobin synthesis has been found to be defective. Radiographic imaging plays a crucial role in the diagnosis of severity of the disorder throughout the different stages of the life of the patients as the same is accompanied by continuous monitoring and selective management. Conducted studies in this context relate to the various aspects of imaging assisting in proper diagnosis and early management of the ill fated patients.

Severe pathological alterations envisage skeletal alterations in  $\beta$ -thalassemia on radiographic process of bone marrow concerning the type of thalassemia. The particular bone responds to the kind of treatment to be undertaken with regards to the extent and duration of the disorder, volume of blood transfusions carried out in the patients and side effect relating to transfusion chelation therapy. The nexus of radiographic features can be duly revealed in the axial and appendicular portions of the skeleton as well as extra medullary parts. Furthermore, abnormal hemoglobin synthesis revokes variable extent of anemia.

Extra - medullary sites consequently turning into a paraspinal mass but rarely affecting organs infiltrated with pluripotent stem cells give rise to erythropoiesis. Repeated transfusions devoid of iron chelation can be considered causative factors of haemosiderosis as iron gets deposited at the unwanted sites resulting in functional impairment. Iron – chelation therapy accompanying desferrioxamine (DFX) subsides haemosiderosis but certainly gives rise to skeletal dysplasia consequently proving detrimental in propagating rapidly growing long bones particularly the distal ulna leading to deformity and eventually resulting in splaying of the metaphysis and sclerosis of the physal metaphyseal joint.

In this new era the modern radiologists are supposed to inculcate the spirit with keen interest to firmly display the classic radiographic features pertaining to thalassemia side tracking classroom files. Alterations in the axial skeleton majorly include skull and facial bones, weight bearing bones, vertebrae, paranasal sinuses but changes have been abundantly earmarked in appendicular skeleton and rapid manifestations have been found to be more pronounced in peripheral bones including hands and feet and ribs also. The patients in which blood transfusions and iron – chelation therapy is carried out at repeated intervals also reveal variable degree of manifestations as compared to the untreated patients deprived of the above treatment. However, (DFX) retards the growth rates as it exacerbates the tissues.

**Keywords:**  $\beta$ -globin, Erythropoiesis, Desferrioxamine (DFX), Extramedullary haematopoiesis (EMH), Hb Bart's hydrops foetalis, Cardiomegaly, Thalassemia syndromes, Maxillary overgrowth (rodent facies), Sickle cell anemia.

## I. INTRODUCTION

Thalassemic bone alterations commence mainly due to overgrowth and increased activity of bone marrow which is exceptionally the most peculiar in all sorts of anaemias. Thalassemia is a hereditary anaemia resulting from defect in the hemoglobin production. It is among the most common genetic disorders worldwide.

Toxicity co-exists following DFX – induced skeletal dysplasia in association with visual and auditory denervation. Hence, careful handling of the transfusion regimen and iron – chelation therapy becomes absolutely essential.

With the advancement in age, peripheral skeletal alterations get curtailed due to replacement of red marrow by fatty marrow. Contrary to the belief the skull, spine and pelvis reveal increased alterations in consonance with advancing age. Pathological alterations bear a direct relationship with erythroid hyperplasia followed by distinct widening of the medullary cavity, thinning of the cortices, increase of bone diameter, fine trabeculae may get sunken and remaining trabeculae bulge out. Extramedullary haematopoiesis gets converted into hepatosplenomegaly and in the posterior mediastinal paraspinal delicate tissues – followed by appearance of haematopoietic material.<sup>1</sup>

The most common combination of beta-thalassemia with abnormal Hb or structural Hb variant with thalassemic properties is HbE/beta-thalassemia which is most prevalent in Southeast Asia where the carrier frequency is around 50%.

The cumulative gene frequency of the three most predominant abnormal haemoglobins, i.e. sickle cell, haemoglobin D and haemoglobin E has been found to be 5.35% in India. Among the inherited disorders of blood, haemoglobinopathy and thalassaemia constitute a major bulk of non-communicable genetic diseases in India. It has been estimated that with a population of 1000 million at the new millennium (2000) and a birth rate of 25 per thousand, there would be about 45 million carriers and about 15,000 infants born each year with haemoglobinopathies in India. The carrier frequency of haemoglobinopathy varies between 3 and 17% in different populations of India.

$\beta$ -thalassemia appear in the form of cluster of hereditary syndromes may be occurring due to diminished or disappearance of  $\beta$  globin chains.  $\beta$ -thalassemia is duly inherited as a recessive gene inducing variable phenotypes emerging from asymptomatic carriers to the typical form of anemia. It is estimated that world over there are 200 million carriers of beta thalassemia gene, out of which about 40 million are in South Asia and 20 million of them are in India alone. This defect has been expressed in about 1.5% population of the world and out of which 60000 population is born as symptomatic per annum. It has been crucially detected that the  $\beta$ -thalassemia mainly affects the people in the homozygous state due to involvement of defective gene in the turbulent times.<sup>2</sup>

Severe form of anemia and utterly failure to restore expectancy within a day has been reported in 'Hese patients' who show improvement following repeated blood transfusions. Lack of an early treatment deficiency may commence with short stature, leg ulcers, lack of muscular development revealing symptoms and signs of severe typical anemia only reporting to correct line of treatment; affected patients may show speedy recovery and thrive potentially to lead suitable onward life. Every year approximately 1 lakh children with thalassemia major are born world over, out of which 10,000 are born in India.

In the turbulent times haphazard happenings in the course of " $\beta$ -Thalassemia major" along with extramedullary hematopoiesis (EMH) can exist well. Before the institution of regular blood transfusion, patients with beta thalassemia major died during the first few years due to improper treatment of the disease and its complications. But now with the availability of better diagnostic and management facilities, this disease has changed its course from a disease of high mortality to a disease of high morbidity.

The only curative treatment for this disease at present is bone marrow transplantation or stem cell transplantation. This procedure is very expensive for the patients in a developing country like India, so what remains as a backbone for the management of thalassemia is lifelong blood transfusion and iron chelation therapy.

Even this conventional treatment is often unavailable for patients in remote areas. So there is an urgent need for every patient in every part of the world to get equal access to quality health care facilities.

The use of regular, frequent blood transfusions has improved the span and quality of life of patients, but has led to chronic iron overload. Iron deposition occurs in almost all the organs of the body but mainly in the heart, liver and endocrine glands. The endocrine disorders include delayed growth, delayed puberty, diabetes mellitus, hypothyroidism, hypoparathyroidism and in adults failure of sexual functions. The reported incidence of impaired glucose tolerance in beta thalassemia major is 4-24% and that of diabetes mellitus is 0-26%.<sup>1</sup>

## II. MATERIALS AND METHODS

The study was carried out in the Department of Radio diagnosis, Bapuji Hospital and Chigateri Government Hospital attached to Jagadguru Jayadeva Murugarajendra Medical College, Davangere over a

period of 24 months. Patients with the signs and symptoms relating to fatigue, weakness, pale or yellowish skin, facial bone deformities, slow growth and abdominal swelling were referred from Pediatrics Departments of JJMMC Davangere. A total of 30 patients were selected on the basis of clinical, Radiographic findings and those with bone deformity were further subjected to biochemical analysis. After taking a properly informed written consent and complete history, thorough clinical examination was carried out and these patients were subjected to radiographic imaging and biochemical analysis.

#### **Pathophysiology of $\alpha$ -Thalassemia:**

Mutation at the  $\alpha$ -gene loci is responsible for a severe defect of  $\alpha$ -globin chain synthesis rendering to trigger  $\alpha$ -thalassemia. Interaction and integration of the paired gene loci in the 2 chromosomes, the phenotypic expressions preclude, hemoglobin (Hb) H disease, Hb Bart's hydrops foetalis and  $\alpha$ -thalassemia trait due to close association of imaging abnormality during foetal life or period of adulthood. Life expectancy and thriving potentiality of red blood cells get diminished, critical level of (Hb) H disease being attained due to haemolysis and insufficient erythropoiesis. About 70-80% patients have been showing hepatosplenomegaly. Extramedullary haematopoiesis is rendered clinically negligible due to its mild nature, hence iron laden form also proves its mildness with the recurrence of gallstones.<sup>1,2</sup>

Foetal haemoglobin is derived from  $2\alpha$ -globin and  $2\gamma$ -globin chains. Therefore, decline in synthesis of  $\alpha$ -globin chains in Hb Bart's disease associated with a severe foetal anaemia results in elevations of intrahepatic umbilical venous maximum flow velocity and middle cerebral artery peak flow velocity. Both can be detected by Doppler US from 21 weeks of gestation onwards. Echogenic bowel triggering hypoperistalsis or bowel wall oedema commencing due to severe anemia and hypoxia has been found to be diagnosed in 31% of the patients with affected features between 3-6 months of gestation.

Typical features and pitfalls involved in severe foetal hypoxia and failure of heart envisage oedema, ascites, dilated umbilical vein, cardiomegaly pericardial and pleural effusion which are well established at 5-7 months of gestation onwards. The relevant cause of hydrops in Southeast Asia quickly responds and is recognized as Hb Bart's disease. Generally these hydroic fetuses attain mortality in utero during the 3<sup>rd</sup> trimester.

Prenatal diagnosis at the initial stage can facilitate in-utero transfusions and pregnancy termination. In cases of pregnant mothers with prenatal complications arising due to pre-eclampsia or polyhydramnios and postpartum mothers revealing massive haemorrhage as a result of increasing placenta or sepsis timely attention can only suffice the purpose for proper and effective management.

Amniocentesis for DNA programming, cordocentesis for foetal blood analysis and US – guided chorionic villus biopsy have been considered as the best options for sure confirmation of Hb Bart's disease.

#### **Pathophysiology of $\beta$ -Thalassemia:**

Mutations at the  $\beta$ -globin gene loci giving rise to defective output of  $\beta$ -globin chains are responsible for  $\beta$ -thalassemia. The main phenotypes which are homozygous and envisage  $\beta$ -thalassemia major or  $\beta$ -thalassemia minor. Hitherto a mild degree of ineffective erythropoiesis is detected in  $\beta$ -thalassemia minor and no imaging abnormalities have been found. Interaction of different thalassemia alleles responsible for  $\beta$ -thalassemia intermedia depicts a varied clinical picture both of  $\beta$ -thalassemia major as well as of  $\beta$ -thalassemia minor.

$\beta$ -globin synthesis disorder generates homozygous  $\beta$ -thalassemia major but production of haemoglobin remains as such with no effect. During imaging studies fetuses with abnormality appears to be normal while visualizing the defect physiologically. Henceforth, the role of imaging finds a suitable place to improvise US – guided prenatal diagnostic techniques, chorionic villus sampling as well as amniocentesis, being standard established techniques at different occasions of the gestation period to obtain fetal DNA which may help in proper diagnosis.<sup>2</sup>

Emerging  $\gamma$ -globin chains get decreased following delivery but the compromised  $\beta$ -globin chain production in homozygous  $\beta$ -thalassemia major results in premature mortality or necrosis of red blood cells. Mortality may ensue in infants due to severe anaemia if presumptive treatment is not followed.

The standard treatment for homozygous  $\beta$ -thalassemia major is ascribed to blood transfusion and for the last 20 years hitherto improvement in life quality and life expectancy of these patients is being observed. Although the clinical and imaging picture of the patient has been standardised according to adequate blood transfusion and application of chelation therapy. Cooley and Lee first time reported the same in the year 1925. Cooley and Lee had brought to light emergence of  $\beta$ -thalassemia for the first time in the year 1925. Most of the findings were sought from the patients of Mediterranean origin from which thalassemia term has been enacted. The diseases has been found prevalent in Turkey, Greece, Italy, India, Thailand, Philippines and in America.<sup>1,2</sup>

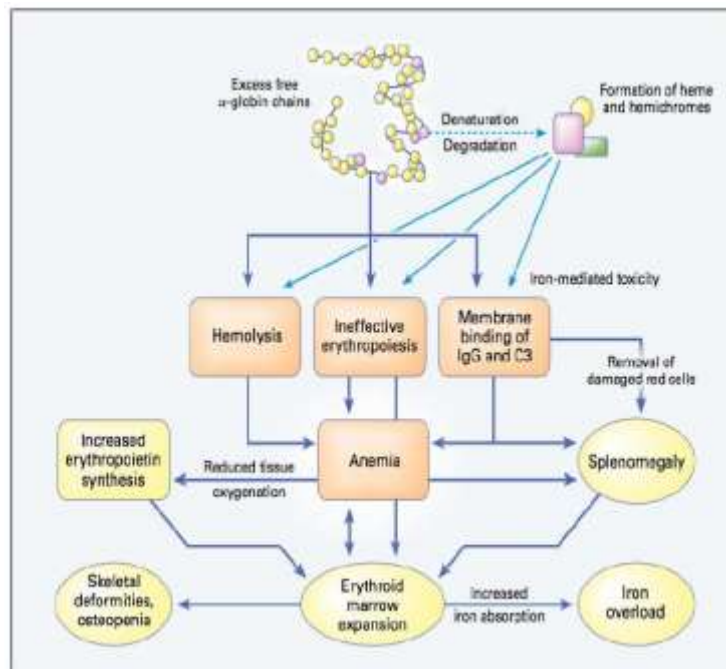
The varied genetic manipulations of thalassemia are held responsible for creating multifarious disorders which are collective in nature and termed as the thalassaemic syndromes. Hitherto 3 general groups have been recognized and classified in consonance with severity of the disorder – (1) Thalassemia minor, (2) Thalassemia intermedia and (3) Thalassemia major. Out of these thalassemia major has been identified as the most critical responding to poorest diagnosis. Thalassemia major depicts typical clinical findings out of all the genetic varieties. However, thalassemia minor and thalassemia intermedia have not shown the severe deleterious effects but prognosis lies in musculoskeletal system manifestations responsible for distinguished osseous alterations.

**Genetic classification**

<b><math>\alpha</math> – Thalassemia</b>	$\alpha^0$ $\alpha^+$
<b><math>\beta</math> – Thalassemia</b>	$\beta^0$ $\beta^+$
<b><math>\delta\beta</math> – Thalassemia</b>	$(\delta\beta)^0$ $(\delta\beta)^+$
<b><math>\gamma</math> – Thalassemia</b>	$\gamma^0$ $\gamma^+$
<b><math>\delta</math> – Thalassemia</b>	$\delta^0$ $\delta^+$

The molecular defect in  $\beta$ -thalassemia results in absent or reduced production of  $\beta$ -globin chains. The  $\alpha$ -globin chains are unaffected and hence there is imbalanced globin chain production, leading to an excess of  $\alpha$ -chains.

In the absence of their partners,  $\alpha$ -chains are unstable and precipitate in the red cell precursors giving rise to large intracellular inclusions that interfere with red cell maturation, resulting in variable degree of intramedullary destruction of red cell precursors, i.e., ineffective erythropoiesis. Those red cells, which mature and enter the circulation, contain  $\alpha$ -chain inclusions that interfere with their passage through the microcirculation of the spleen. The damage to the red cell precursors and their progeny in  $\beta$ -thalassemia is not entirely mechanical.<sup>3,4</sup>



**Fig 1** Pathophysiology of thalassemia.

**Marrow hyperplasia** – Represents the serious osseous expressions which are further characterized with generalized cortical thinning, spreading of bone caliber, coarsened trabecular pattern (honey comb, enlarged vascular channels, osteoporosis and widened medullary cavity).<sup>1,2</sup>

**Growth disturbances** – In sufficient remodeling with the frame work of bones is fairly by responsible for under tabulation especially at the metaphyseal junction. Henceforth an Erlenmeyer flask type deformity appears occasionally. Premature fusion of a part of growth plate may ensue dwarfness and deformity especially in the distal femur and proximal humerus. Transverse linear opacities in the metaphysis are more frequent representing severe form of growth arrest lines.<sup>1,2</sup>

**Miscellaneous** – Arthropathy, hemochromatosis, chondrocalcinosis, avascular necrosis, fractures and on certain occasions paraspinal opaque hemosiderin laden lymphnodes may be detected. In addition to it, hepatosplenomegaly, cardiomegaly and paraspinal soft tissue material (extramedullary haematopoiesis) may be visualized as well.<sup>1,2</sup>

### **RADIOGRAPHIC FEATURES<sup>1,2</sup>:**

#### **Alterations in the skull:**

Thalassemia responds to highly pronounced alterations in the skull out of all the existing anemias. In the calvaria, pronounced changes have been ever noticed below the inferior occipital protuberance due to insufficient marrow in this particular zone. The earliest critical alterations ensue in the frontal bones. Three kinds of alterations make their appearance – widened diploe, granular osteoporosis, and vertical radiating spicules of new bone (hair – on – end appearance) accompanied by loss of definition of the outer table. At various occasions circumscribed lytic lesions of the calvarias upto 5 cm can be noticed vascular markings from the middle meningeal arteries become prominent and show size increase.

The effects of erythroid hyperplasia are more critical especially in the facial bones. The severe abnormalities have been reported due to insufficient pneumatization of the frontal mastoid air cells and maxillary bones but the ethmoids which remain aerated are to be affected. However, the orbits are displaced laterally, but upper increase may be displaced forward revealing malocclusions (rodent facies).<sup>1,2</sup>

#### **Long bones:**

Manifestations of erythroid hyperplasia have been excellently reported in the appendicular skeleton. The medullary cavity gets broadened, cortices get thinned and trabeculae remain sparse but coarsened (honey comb) i.e. nutrient foramina.

Total hepatic iron concentration has been found to be an ideal indicator for assessing total iron stores and hemochromatosis as per laboratory findings. Strategy has been fairly opted in its treatment which has revived on average the survival rate to the 4<sup>th</sup> decade.

These days, modern treatment modalities are in vogue which include bone marrow transfusions, gene therapy and stem cell transplantations to facilitate improvement in quality life expectations. Arthralgia (30%) and low back pain (25%) are generally encountered but the locomotor system shows effectiveness in 60% of patients and scoliosis is only identified in about 40% of cases. Major concern is that survival is sustained beyond first phase consisting of initial years of life. Blood transfusions and chelation therapy are the recent treatment techniques now available. However, repeated blood transfusions resultantly resort to hemochromatosis and subsequently cardiac failure and death ensues by the 2<sup>nd</sup> or 3<sup>rd</sup> decade of life. Moreover, physical deprivations include stunted growth, hepatosplenomegaly, maxillary overgrowth (rodent facies), lethargy, pallor and retarded sexual development. These abnormalities may be seen during the last period of first year of life. On the rare occasions epidural extramedullary hematopoietic tissue in the spinal cord triggers spinal cord compressions.

Laboratory findings set a destined goal to expose hypochromic microcytic anemia, nucleated red blood cells, elevated serum bilirubin, target cells and reticulocytosis. Many abnormal haemoglobins result from varied genetic variations.

In thalassemia major radiographic manifestations are severe and common. The radiograph bears a parallel relationship in consonance with degree of marrow hyperplasia which gets increased. It has been often observed that the tubular bones remain osteoporotic and deficient in the normal metaphyseal – diaphyseal concave constriction at some intervals giving rise to ‘Erlenmeyer flask deformity’. Medullary infarcts in an organized way are uncommon as compared to sickle cell anaemia. In a peculiar form of deformity partial premature closure of growth plates have been duly observed. Certainly avascular necrosis of the femoral head takes places but not to a considerable extent as compared to sickle cell anemia.<sup>1,2</sup>

**Chest:**

In a pertinent way cardiomegaly has to be sensibly sorted out. Posterior mediastinal extramedullary haematopoietic masses become crystal clear as bilateral opaque paraspinal lobulated masses.<sup>2</sup>

**Spine:**

Pronounced and distinguished alterations in the spine compromise of coarse vertical trabecular, thin cortical outlines and osteopenia and specific involvement of both the body and neural arch of each segment. Such symptoms do make their appearances in the sacrum and the pelvis. However, generalized concavity of the endplates become clearly visible but the discrete, central end plate depression as seen in sickle cell anemia has not been invariably seen in this condition. Furthermore, alterations may involve enlargement and exaggeration of the anterior body vascular notch, dense, the small ring apophyses and growth arrest lines. It becomes pertinent to point out that the spinal and pelvic lesions do exist tremendously with growing age in such a way that suppression of bone changes may also be revealed. Extramedullary haematopoiesis interacting with spinal cord or nerve roots may be prevailing at some few occasions. To assess and to clearly earmark these lesions MRI and CT techniques have proved as platinum standard techniques. MRI facilitates exposure of heterogenous mass on both T1 and T2 weighted images followed by enlargement on the basis of paramagnetic agents.<sup>1,2</sup>

**DISCUSSION:**

Haematopoiesis is regulated in a proper form to compensate very low haemoglobin status and the respective organs outside the bone marrow start the process production of red blood cells (erythrocytes) in  $\beta$ -thalassemia major, as well as in myeloproliferative dysfunctioning and other blood dyscrasias and the process pertains to EMH. The same process of EMH has been taking place in the liver and spleen where haematopoiesis generally occurs during fetal development. Hepatosplenomegaly accompanying with usual manifestations resulting from resumed red blood synthesis and decrease in filtering capacity in the spleen occurs to a considerable extent. On the other hand EMH may be going on at other sites rarely and thereby involvement of multisystem is established. However, other body organs reveal their involvement only upto a marginal extent with EMH including lung and pleura, lymphnodes, central nervous system, pelvis, joints, ribs and spine.

EMH which is being going on at these unusual sites should be suspected and further ascertained in the form of abnormal multi-systemic hematopoietic tissue production in the patient to be known as  $\beta$ -thalassemia patient.

Thalassemia induces a skeletal response to the cause of chronic anemia accompanying marrow hyperplasia. While chalking out imaging, medullary spread with resorption of the trabecular bone as well as decline in the cortical bone ensues.

**CONCLUSION:**

EMH pertaining to  $\beta$ -thalassemia may expose varied imaging presentations with involvement of various multiple anatomical locations. The authors have presented a peculiar noticeable case in hands with excessive implications involving rib cage, mediastinum and pelvis. Experts and guides well versed with the latest techniques in Radio-diagnosis should be well acquainted with complications involved in intricate treatment of patients with  $\beta$ -thalassemia to enable and to reorient their unique attention to focus only on the relevant sites and express the generous views in concern of appropriate diagnosis being undertaken to target the relevant aim strictly adhering to norms and procedures laid down in operation of the concerned machines.

**ACKNOWLEDGEMENT:**

The authors bear a sense of gratitude and overwhelmed with sincere efforts of the assisting staff with whose help experimental trials were undertaken to accomplish proper diagnosis of a few peculiar cases in the Radio-Diagnosis Department of JJM Medical College & Hospital, Davangere (Karnataka). Indebtness in concern of expert guidance of senior colleagues and timely help rendered by subordinate staff will leave an indelible impression in the minds forever; hitherto and in future also.

**CASE REPORT:**

A 8 year-old female child with beta thalassemia major presented with a 15-day history of worsening gait and with recent onset of nausea, vomiting, unable to walk, failure to thrive, repeated bouts of respiratory infections, disequilibrium. Four months prior to presentation the patient reported a self limited episode of low back pain. Two months after this episode he noted numbness and tingling of her legs that had progressed to her current gait disturbance. An outpatient pediatric neurologist noted clonus on the patient's physical exam.

The child dentition was irregular and had caries in 3 of the teeth. The abdomen was protuberant due to laxity of the abdominal wall. On examination the patient was found to be anemic.



- X-ray chest: expansions of the ribs particularly in the middle and anterior portions of the ribs.
- X-ray skull: widened diploic spaces predominantly involving frontal and occipital bones
- X-ray both hands: phalanges are squared and show very thinned endosteal cortex with relatively wide medullary cavity and abnormal density.
- X-ray TL spine lateral: resorption of some trabeculae and remaining trabeculae appear thick and prominent.

A 7 year-old child presented with abdominal pain, loss of appetite, low grade fever and anaemia. Few days later patient developed fever, chills and severe pallor with bouts of respiratory and GIT infection. He was diagnosed with severe anaemia with Haemoglobin (Hb) being 5.6g% and was transfused with two units of blood. His condition improved and he was prescribed haematinics at the time of discharge. On clinical examination hepatosplenomegaly noted. After a few day, he subsequently developed fever with chills, this time accompanied with anorexia and abdominal pain.



- X-ray skull: widened frontal and parietal diploic spaces noted.
- X-ray TL spine lateral: decreased bone density with vertical prominent trabeculae.
- X-ray chest AP: expansion of the ribs on right anterior aspect noted.

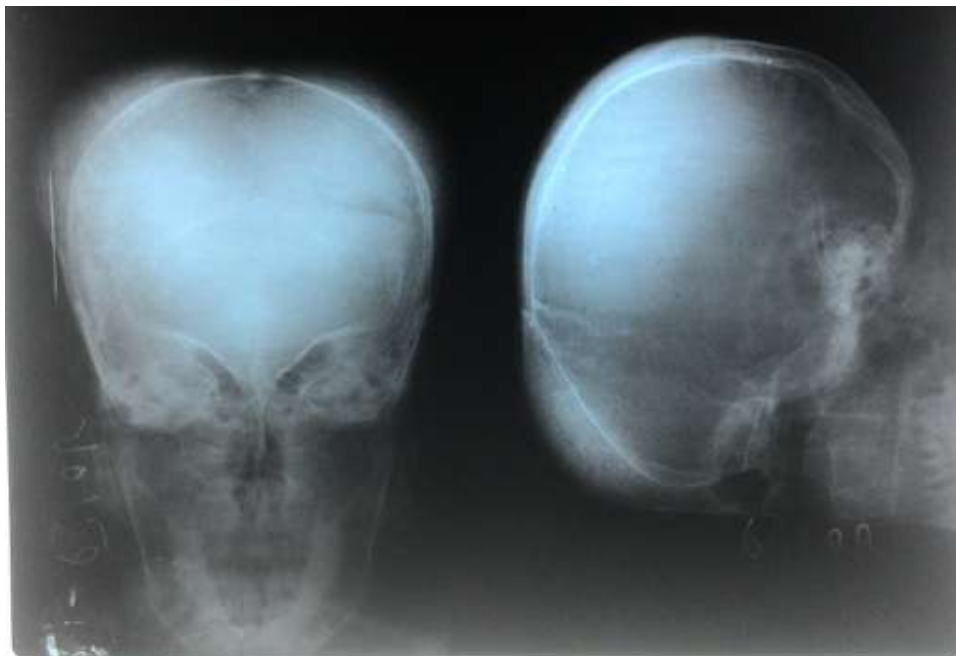
A 10-year-old female child with known beta thalassemia, born out of consanguineous marriage came with complaints of breathlessness on exertion, generalised fatigability and weakness. On examination the patient had hepatosplenomegaly. Her haemoglobin (Hb) was 5.6 g/dl and peripheral smear revealed hypochromic, microcytic red blood cells with target cells. Serum iron studies revealed serum iron of 300 mg/dl (200–400 mg/dl) and serum ferritin of 1500 ng/ml (20–300 ng/ml).



- X-ray chest AP: rib within-a-rib appearance noted in the anterior aspect of the ribs
- X-ray skull: widened frontal diploic spaces.
- X-ray TL spine lateral: decreased bone density and thickened vertical trabeculations.
- X-ray both hands: decreased bone density with coarse trabeculae, wide medullary cavity with thin cortex with squared phalanges.



A 17 year old male patient, with known beta thalassemia intermedia, presented with complaints of chronic headache during the last two months, with recent onset of nausea, vomiting, unable to walk, short stature, failure to thrive, repeated bouts of respiratory infections, disequilibrium and rapid progressive visual loss. He had pallor of the skin with a cachectic appearance and a prominent skull deformity with hepatomegaly. Neurological examination showed bilateral severe optic disc atrophy and his visual acuity revealed no light perception (NLP) in both eyes. His extra ocular movements and examination of his other cranial nerves were normal. His speech and sensorium were intact but there was gait disturbance due to disequilibrium



- X-ray skull – widened diploic spaces with vertically radiating spicules noted in the frontal bone (hair on end appearance)with loss of definition of outer table radiating spicules extending upto the occipital protuberance (majorly in the frontal bone)
- X-ray right hand: decreased bone density and coarse trabecular pattern s/o osteopenia.

**REFERENCES**

- [1]. Lindsay J. Rowe and Terry R. Yochum. Hematologic and vascular disorders. Chapter-13, In: Yochum & Row's Essential of Skeletal Radiology. 3<sup>rd</sup> ed. Philadelphia: Lippincott Williams and Wilkins; 2005 pp.1432-36.
- [2]. Asif Saifuddin. Bone marrow disorders : Miscellaneous. Chapter-72, In: Grainger & Allison's Diagnostic Radiology, Andreas Adam, Adrian K. Dixon, Jonathan H. Gillard ed., 6<sup>th</sup> ed., Vol.2, Churchill Livingstone; Elsevier; 2015 .pp.1728-33.
- [3]. Weatherall DJ, Clegg JB. The Thalassemia syndromes. 4<sup>th</sup> ed. Oxford, England: Blackwell science Ltd; 2001.
- [4]. Olivier NF. The " Thalassemias. N Engl J Med 1999; 341(2): 99-109.