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Nutritional Status Assessment of Children with Nutritional Rickets Under Five Years at District Headquarter Hospital, Upper Dir- Pakistan

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Abstract

A cross- sectional study was conducted to assess the nutritional status of the children with rickets aged <5 years at District Headquarter Hospital, Upper Dir in which 50 children were included 33 (66%) male and 17 (34%) female. The study included anthropometric measurement (weight, height and head circumference), clinical presentation, radiographic findings, biochemical assessments, dietary status and information about exposure to sun. clinical results reveal that all children were having one or more clinical signs and symptoms of nutritional rickets including rachitic rosary (14%), widely open anterior fontanel (22%), widening of wrist (14%), bowing of legs (14%), chest infection (22%), diarrhea (10%), delayed eruption of teeth (24%), failure to thrive (10%), fits (4%), sweating (26%) and irritability (20%). The radiographic features of the subjects indicates 84% cupping, 28% splaying, 14% fraying and 40% widening of wrist. The observed mean values of serum calcium and alkaline phosphatase (ALP) were 8.11 ± 0.56 mg/dl and 1219 ± 566 IU/L respectively. Mean age of the subjects was 15.16 ± 11.18 months, mean weight was 7.87 ± 3.02 kg, mean height was 69.29 ± 10.62 cm and the mean head circumference was 46.41 ± 3.31 cm. The mean values of weight-for-age z-score (WAZ), height-for-age z-score (HAZ), weight-for-height z-score (WHZ) and head circumference-for-age z-score (HCAZ) were -1.78 ± 0.95, -3.28 ± 0.56, -2.55 ± 0.92 and 0.79 ± 0.95, respectively. It was concluded that the cultural norms include the infants wrapping in cloths while sleeping, exclusive breast feeding for long time and lack of parent's awareness about sun exposure and inadequate complementary food are adversely affect the nutritional status of the children that leads to rickets.

Keywords: Radiographic findings; Nutritional rickets; Delayed eruption

Introduction

Rickets causes bone deformities through the impaired mineralization of actively growing bone [1]. The growing bones of children to fail correctly do not calcify themselves and become twisted by the weight of the body and to draw it from the muscles [2]. There are different kinds of rickets such as the insufficiency of the vitamin D, the D-dependent rickets, resistant to the vitamin D and renal of vitamin Nutritional rickets, be also called as rickets of insufficiency of vitamin-D, the principal type of rickets brought back in the whole world. This is a childhood disease with the bone defects of shape, bone pain, convulsions, or delayed development guide [3]. The rickets is caused by deficiency of vitamin D. Deficiency of vitamin D may occur due to insufficient intake or less exposure to ultra violet rays of sun or a combination to the two. The insufficiency of vitamin D is the main cause of the nutritional rickets but current reports suggest that an inadequate calcium or phosphorus intake is also an important cause of rickets [4]. Calcium or calcium and vitamin D supplements recover children with rickets more quickly than the vitamin D alone [1,5].

Very few foods naturally contain vitamin D. Breast milk has a low concentration of vitamin D, is an important factor for the infants fed exclusively with the center for an extended period. Fish, meat (such as salmon, tuna, and mackerel) and fish-liver oil are a good source of vitamin D. vitamin D is found in the liver, beef, cheese, egg yolk in a small amount [3,6,7]. Besides, foods high in calcium should also be utilized [8].

In Pakistan, despite plenty of sunshine, nutritional rickets is not rare [9]. In Pakistan, 2.25% rickets has been reported in children [10]. Similarly Siddiqui and Rai (2005) also reported 60 cases of children with rickets during the study period [11]. As Upper Dir is a hilly area with poor sun exposure and wrapping habits of mother, cases are reported from this area more often. Therefore, this study was designed to assess the nutritional status of the children with rickets and to determine the possible contributing factors of rickets in Upper Dir [12]. This will help the health authorities to properly plan and implement actions for the eradication of the problem in the area.

Materials and Methods

Location of Study

The study was conducted from August, 2016 to January, 2017 at the Pediatric Department, District Headquarter Hospital (DHQ); Upper Dir. DHQ Upper Dir is one of the well equipped Government hospitals providing health care facilities to the population of the Upper Dir.

Sample Size and Criteria for Sample Selection

Inclusion Criteria: A total of 50 patients under the age of five, diagnosed with rickets were selected for the study. Patients presenting with the recurrent lower respiratory tract infection, convulsions, delayed developmental mile stones, delayed teething, chronic diarrhoea, increased tendency of bone fractures and poor weight gain were specifically included.

Exclusion Criteria: Patients with renal rickets, hypophosphatemia rickets, and drug-induced rickets were excluded.

Collection of Data

The following information were collected and recorded in the questionnaires:

Clinical Assessment: With the help of the concerned doctor (specialist) at District Headquarter Hospital, all the patients were looked for the following specific signs of rickets including the bone x-rays and the observations were recorded in the specific questionnaire. Osseous pain or tenderness, skeletal malformations, tendency increased towards osseous fractures, dental malformations, muscular cramps, slowing down the growth and small stature

Blood collection, processing, separation of serum and storage: Fresh venous blood (2cc) was taken from vein in a 5cc syringe and transferred to the tube. The serum was separated from the blood by the help of centrifuge. The sample was stored at 2-25 °C in refrigerator [13-15].

Determination of Serum Calcium: Cresolphthalein method was used to determine serum calcium level. In this method calcium ions in the serum form violet complex with the reagent, cresolphthalein in alkaline media. The intensity of the violet color of the solution was measured by spectrophotometer [16]. Calcium react with o-Cresolphthalein Complexone in the presence of Alkaline medium to form Calcium-Cresolphthalein Complexone Complex (purple color). Color reagent: o-Cresolphthalein méthylthymol 0.11mm, 8 hydroxyquinoléine 17.0mm, surface-active agent. Reactive plug: 2-amino-2-methyl-1-propanol 976 mm, 2.0 mm cyanide potassium. All glass wares were rinsed out of hydrochloric acid diluted before employment. The entire reagent was stored at 2-8 °C. Equal volume of the mixture of reagent of color and shock absorber were combined and left the support during twenty minutes with the room temperature before employment. Reagents were combined in clean plastic ships. Zero spectrophotometer with blank at 570nm was used [17-20].

Alkaline phosphates (ALP): In this method ALP catalyzes the reaction of p-nitro phenyl phosphate with water to form phosphate and p.nitrophenol. This activity is then measured by photometric calorimetric method. This test has developed to determine ALP activities which correspond to a maximal absorbance reading calculate ΔA/min of 0.25 (The Kinetic Method). The equipments used were Photocalometric, microlab300, glassware, test tube, water bath, centrifuge, micro juster. R1: Diethanolamine pH 9.8 1.2mol/L, Megnesium chloride 0.6mmol/LR2: p Nitrophenylphosphate 50mmol/L. The reagents were stored at 2-8°C. An elastic band around the upper arm was wrapped to stop the flow of blood [21-27]. The needle was put into the vain and collects the blood in a tube. The spectrophotometer/ filter photometer was set to zero absorbance at 410 nm/ violet filter against 0.25NaOH and measure the absorbance. After the combination of R1 and R2 as directed, the reagent contains: P-nitrophényle phosphates 17 millimetres, magnesium ions 4 millimetres, activators and bindings of shock absorber (± 10.2 of pH 0.2) [28,29].

Anthropometric Measurements: Weight, height/recumbent length and head circumference were determined by following the World Health Organization recommended procedures (WHO, 1995) and recorded in the questionnaire. Weight of the children were measured by bathroom scale which were standardized with standard weights before taking measurements of children, and then after each ten measurements [30]. The wooden length board and height board were used for measuring the recumbent length and standing height of the subjects, respectively. The head circumference was measured by using an ordinary measuring tape (non-stretchable) or insertion tape to the nearest 0.1 cm.

Dietary Assessment: Information about the dietetic ingestion of energy, the protein, calcium, phosphorus and the vitamin D were obtained by using food frequency questionnaire.

Exposure to Sunshine: To evaluate exposure to sunshine, some other predisposed factors like type of house (single storey/multi-storey building), location of house (isolated building or not), awareness and body wrapped were determined by interviewed the attendants with patients.

Data Entry and Statistical Analysis

Data regarded demographic, socioeconomic, clinical and radiographic, biochemical and dietary concentration was entered into the computer. Based on the distribution of data, basic descriptive and appropriate statistical tests were used to determine the statistical significance between different variables by using SPSS. Dietary assessment was calculated in NutriSurvey (2007). A 5% level of significance was applied to examine the mean differences between the variables.

Results

As stated earlier this study was designed to assess the nutritional status of children (old 0-5 years) with nutritional rickets in Upper Dir and to determine the possible contributing factors of the nutritional rickets. For this purpose, a total of 50 patients having clinical suggestive of rickets were enrolled which included 66% males and 34% females (Table 1). Majority of the subjects were from rural areas (62%) as compared to the urban (38%).

Area	Male	Female	Total (%)
Urban	12	7	19 (38)
Rural	21	10	31 (62)
Total (%)	33 (66)	17 (34)	50 (100)

Table 1: Area and Gender Distribution

Clinical Assessment of the Subjects

Table 2 shows the important clinical features of the rickets patients. The most common clinical features included rachitic rosary (14%), widely open anterior fontanel (22%), widening of wrist (14%), bowing of legs (14%), chest infection (22%), diarrhoea (10%), delayed eruption of teeth (24%), failure to thrive (10%), fits (4%), sweating (26%) and irritability (20%). The clinical results reveal that all children were having one or more clinical signs and symptoms of nutritional rickets.

Signs and Symptoms	N (%)
Rachitic rosary	7 (14)
Widely open anterior fontanel	11 (22)
Widening of wrist	7 (14)
Bowing of legs	7 (14)
Chest infection	11 (22)
Diarrhoea	5 (10)
Delayed eruption of teeth	12 (24)
failure to thrive	5 (10)
Fits	2 (4)
Sweating	13 (26)
Irritability	10 (20)

Table 2: Clinical features of the subjects (N=50)

Radiographic Assessment of the Subjects

Table 3 showed clinical features of the suspected nutritional rickets in subjects were then confirmed through radiographic and biochemical assessments. The radiographic features of the subjects indicates 84% cupping 28% splaying, 14% fraying and 40% widening of wrist .The radiographic results unveil that the subjects were having one or more signs of rickets.

Radiographic Features	N (%)
Cupping	42 (84)
Splaying	14 (28)
Fraying	7 (14)
Widening of wrist	20 (40)

Table 3: Radiographic features of the subjects

Biochemical Assessment of the Subjects

Though serum vitamin D level is an appropriate indicator for diagnosing nutrition rickets, but due to financial constraints and lack of laboratory facilities, its determination was not performed in the present study. Therefore, biochemical assessment was done indirectly by serum calcium and alkaline phosphatase (ALP) levels. Table 4 presents the biochemical data of the selected patients including serum calcium and ALP levels. The observed mean values of serum calcium and ALP were 8.11 ± 0.56 mg/dl and 1219 ± 566 IU/L. This shows that the mean value of serum calcium lies at the bottom of normal range whereas the value of ALP was very much raised above the normal range. The elevated serum ALP value could be an indication of the nutritional rickets among the subjects.

Variables	Reference ranges*	Mean ± SD
Serum calcium (mg/dl)	8.1 – 10.4	8.11 ± 0.56
Serum ALP (IU/L)	145 – 450	1219 ± 566

* These values are obtained starting from Nicholson JF, Pesce MY (2004) beaches of reference for the tests of laboratory and the procedures. In: Behrman RE, psychosocial intervention RM, Jenson HB (eds) Nelson textbook of Pediatrics, 18th éd. Chapter 710, pp 2948, Philadelphia, Pa: W.B. Saunders Company.

Table 4: Biochemical profile of the subjects (N=50)

Age and Anthropometric Measurements of the Subjects

The anthropometric characteristics of the subjects are presented in the table 5. The results show that the average age of subjects was 15.16 ± 11.18 months, mean weight was 7.87 ± 3.02 kg, mean height was 69.29 ± 10.62 cm and the mean head circumference was 46.41 ± 3.31 cm.

Measurements	Mean ± S.D.
Age (months)	15.16 ± 11.18
Weight (kg)	7.87 ± 3.02
Height (cm)	69.29 ± 10.62
Head Circumference (cm)	46.41 ± 3.31
Weight-for-age z score	-1.78 ± 0.95
Height-for-age z score	-3.28 ± 0.56
Weight-for-height z score	-2.55 ± 0.92
Head circumference-for-age z score	0.79 ± 0.95

Table 5: Anthropometric characteristics of the subjects (n=50)

Median values of the Z-score of weight-for-age (WAZ), of the Z-score of size-for-age (HAZ), of the Z-score of weight-for-size (WHZ) and of the principal Z-score of circumference-for-age (HCAZ) were -1.78 ± 0.95, -3.28 ± 0.56, -2.55 ± 0.92 and 0.79 ± 0.95, respectively. The results clearly indicate the presence of stunting and wasting in subjects.

Prevalence of Malnutrition in the Rickety Subjects (N=50)

Prevalence of malnutrition based on Z-score of weight-for-age (WAZ), Z-score of size-for-age (HAZ), Z-score of weight-for-size (WHZ) and principal Z-score of circumference-for-age (HCAZ) is given in Table 6. The results reveal that out of 50 subjects, 48% were underweight, 74% stunted, 24% wasted and 10% were having large head circumference. These findings confirm the fact that rickety children suffer from malnutrition.

Malnutrition Indicators*		Subjects	
		N	%
WAZ	Underweight	24	48
	Normal	26	52
HAZ	Stunted	37	74
	Normal	13	26
WHZ	Wasted	12	24
	Normal	38	76
HCAZ	Large	5	10
	Normal	45	90

*Classification of the indicators as Underweight, stunted, wasted and large heads are based on the WHO recommended cut off levels of z-score < -2, whereas z-score ≥ -2 is considered normal for all indictors.

Table 6: Prevalence of malnutrition in the subjects with Rickets (N=50)

Nutrient Intake of the Subjects

Nutrient Intake of the Subjects

Dietary assessment was done by categorizing the subjects into two groups viz. the subjects who meet the daily recommended dietary intakes were termed as ADEQUATE and the subjects whose dietary intake is less than the recommended daily dietary intakes were called as INADEQUATE.

Table 7 shows dietary status of the rickety children. Out of 50 patients, 20% has adequate energy intake versus 80% of the subjects with deficient intake. Protein intake was also inadequate in most of the subjects (58%). The high percentages of inadequate energy and protein intakes clearly indicate that diet may be one of the causes of the malnutrition in the subjects. Most of the subjects were also having inadequate calcium (86%) and phosphorus (96%) intakes. Whereas, all of the subjects were having inadequate vitamin D intake. These findings demonstrate that the insufficient intake of calcium, phosphorus and vitamin D leads to rickets nutritional among the selected children.

Nutrients	Adequate* n (%)	Inadequate** n (%)
Energy	10 (20)	40 (80)
Protein	21 (42)	29 (58)
Calcium	7 (14)	43 (86)
Phosphorus	4 (8)	46 (92)
Vitamin D	0 (0)	50 (100)

* Subjects with the daily intake and according to the recommended diet allowance
** Subject that the daily intake is less than the recommended dietary allowances
Table 7: Nutrient Intake of the rickety subjects (N=50)

Exposure to Sun of the Subjects

Table 8 shows the exposure of subjects to sunshine. Two groups of the subjects were made on the basis of no or little exposure to sunshine (<3 times /week) and enough exposure to sunshine (≥3 times/week). Out of 50 subjects, 48% have no or little exposure to sunshine while 52% were having sun exposure. The results also indicate that more urban subjects (74%) were exposed to sun as compared to rural subjects (39%). In contrast, 26% urban and 61% rural subjects were having little or no exposure to sun.

Exposure to sun	Urban (n=19)	Rural (n=31)	Total (n=50)
	n (%)	n (%)	n (%)
No	5 (26)	19 (61)	24 (48)
Yes	14 (74)	12 (39)	26 (52)
Total	19 (100)	31 (100)	50 (100)

* p-value = 0.03
Table 8: Exposure to sun of the subjects by Area*

Discussion

The study was designed to assess the nutritional status of the children with rickets and to determine the possible contributing factors of rickets in Upper Dir. The findings confirm the fact that rickety children suffer from malnutrition. Moreover the cultural norms include the infants wrapping in cloths while sleeping, Exclusive breast feeding for long time and lack of parent's awareness about sun exposure and complementary food are the contributing factors which leads to nutritional rickets. The similar clinical findings were also presented by Abdel Megeid and Al Abdul Karim (2011) who reported 2% rachitic rosary, 11% skeletal deformity, 28% enlargement of head, 30% delayed closure of anterior fontanelle, 4% delayed eruption of teeth, 19% dwarfism and 17% convulsions in Saudi children [31-33]. Garabédian and Ben-Mekhbi (1999) stated that vit D dependent rickets in children can lead to clinical features can cause skeletal deformation, fatigue, growth retardation, problems of respiration, arthrosclerosis [34-36]. Researchers have reported clinical manifestation of nutritional rickets both in developed and developing countries. Several researchers have reported clinical manifestation in Pakistani children with nutritional rickets. Similar radiographic features results were also presented by Siddiqui and Rai (2005) who indicated 85% Metaphyseal convey/tearing, Located at the bottom of the range of x-rays and the ulna, and the bone density decreased [11]. Radiographic evaluation is another biomarquor of vitamin D Gordon et al. (2007) detected demineralization transmit by radio graphically in a third of patients presenting the rickets, while in a local study by Ahmed and others (2011), one found it in cases of 54% [37-40]. As the rickets can thus cause biochemical significant morbidity and radiological sifting, not counting the clinical evaluation, are a suitable consideration. In another study, Fida (2003) reported hypocalcaemia (mean ± SD: 2.34 ± 0.24 mg/dl) and elevated serum ALP (mean ± SD: 1067 ± 452) in rickety children [41,42]. Prevalence of malnutrition in rickety children has also been reported by Pakistani researchers. Siddiqui and Rai (2005) reported that 24 (40 %) of children with rickets are underweight according Gómez classification of malnutrition [11]. Recently, Jan et al. (2011) reported 70% malnutrition in rickety children of Peshawar valley [43,44]. The results of this study are in fair agreement with the conclusions of Robinson et al. (2006) who reported that 89% subjects were not exposed to the sun [45-48]. In

another study, Haider et al. (2010) reported that the frequency of rickets was higher in children who had little or no exposure to sunlight of those who have the exposure to sunlight (98.3 % vs. 55.1 %) [49,50].

Conclusion

As Upper Dir is a hilly and cold area, so most of the children living in Upper Dir are covered in warm cloths most of time in a day, and are not exposed to sun. Moreover the cultural norms include the infants wrapping in cloths while sleeping, exclusive breast feeding for long time, lack of parent's awareness about sun exposure and complementary food are associated with rickets development. Biochemical investigation is comprehensive indicator for nutritional rickets. Children are deficient in vitamin D, calcium leading to rickets associated with multiple complications. We recommended that our food products must be fortified with vitamin D, Calcium and Phosphorus. Furthermore those infants who are exclusive Breast feed should get vitamin D supplements after a period of four months. Vitamin D contents of breast milk are insufficient for infants after a period of one month. Exposure to sun is also a good source of vitamin D for Infants and as well as for parents. They should be educated about sun exposure and time of complementary food to start. With these Changes we can prevent our children from getting rickets and its complications.

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