

# Pilot Study of DEXA Estimation in Pediatric Sick Patients (January-May 2017) At SGT Medical College Gurgaon (Haryana): How To Achieve The Best Results For The Management?

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## ABSTRACT

**Background:** Osteoporosis can be seen in children because of chronic medical illness or medication. The evaluation leads to decrease risk of fractures by early intervention and management. A radiologist has to play an important role in the interpretation of the DEXA (Dual Energy X-ray Absorptiometry) examination results in pediatric age group. The role extends to the level of knowledge being statistician, orthopedic specialist and clinical pathologist. The various factors have been explored which affects the bone mineral density and have been compared with the available standard database. Bone mineral density (BMD) adds to detailed status of overall bone health. There have been many factors which affect the growing skeleton in children. The radiologist should know the technical aspect of acquiring the information. The interpretation is always based on the additional information other than DEXA scan. Osteoporosis is diagnosed with Z scoring and other biochemical evaluation parameters. T-scores in adults are totally different from the children group. **Methods:** Twenty pediatric patients (n=20) were subjected to DEXA examination from January to May 2017. All these children were from 10-19 years age group with mixed gender. These patients were of symptoms of common ailments as that of respiratory, renal, gastrointestinal and others. **Results:** Ten out of twenty (50%) cases were found to be having osteopenia or osteoporosis. The sensitivity of picking up the bone density was high in estimation of lumbosacral spine as compared to the femoral neck region. One case of malabsorption syndrome was exclusively having osteopenia (10%) and others were found to be having osteoporosis (90%). The common positive ailments were found to be that of tuberculosis (40%), malabsorption (30%), kidney disease (10%), diabetes mellitus (10%) and worms infestation (10%). Males were dominating in this group (72.7%) as compared to females (27.2%). Three (15%) were declared as of normal range. **Conclusion:** DEXA scan Z-scoring estimation is very sensitive method for diagnosing osteoporosis and osteopenia among pediatric age group. This is non-invasive with minimal non-harmful radiation exposure. This is useful in the chronic ailments like tuberculosis, diabetes mellitus, malabsorption syndrome and kidney diseases. This is helpful in preventing the risks of fractures among these vulnerable patients.

**Keywords:** Osteoporosis; DEXA; BMD; Z score; T score.

## INTRODUCTION

The incidence of osteoporosis can occur in children because of some primary bone disorders or secondary illness. The latter group includes those having indirect effects like immobility, anaemia, malabsorption and inflammation. Medication can also cause depletion of bone contents like that of steroids and chemotherapy. DEXA was introduced in 1987 and now it is widely used for the diagnosis. The interpretation of DEXA in children is quite challenging as there is continuous changing bone structure because of the ongoing development. The interpretation is in the form of numbers and the radiologist should have sufficient knowledge for the

clinical correlation. There are various factors which can influence the results like height, weight, body composition, gender, ethnicity and the physiological maturity. The patient nutritional and physical activity history is important for the evaluation

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### Equipment and Procedure

All the cases were carried out on Hologen Discovery Wi (S/N 8835) model (Figure 1). The proper consent of the patient was taken. Lumbar region and femoral

neck regions were included in the scanning. L1 to L4 vertebrae were taken into consideration. All the metal articles like buttons and clips etc. were removed before the test. The radiation dose of this test is 0.001 mSv which is equivalent to three hours of natural background radiation.



Figure 1: Hologen Discovery DEXA- scan machine with padded table top and overhead detector.

### MATERIALS AND METHODS

Twenty pediatric patients (n=20) were subjected to DEXA examination at SGT Medical College Gurgaon from January to May 2017 (Figure 2). These patients were of symptoms of common ailments as that of respiratory, renal, gastrointestinal and others (Figure 3). The group constituted of 11 male (55%) and 9 females (45%). The age ranged from 10-19 years (average 15.05 year). The weight ranged from 22-70 kg (average 43.4 kg). The height ranged from 131-170 cm (average 149.15 cm) (Table 1). Two sites were chosen for the examination as that of lumbosacral spine and either of femoral necks. The proper protocol was followed as described.

### RESULTS

The estimation was evaluated as per WHO Z-scoring. The values less than -2.5 was taken as that of osteopenia and more than that was counted among osteoporosis. Ten out of twenty (50%) cases were found to be having osteopenia or osteoporosis. The incidence of decreased BMD was more seen in male patients (40%) as compared to female (15%) group (Figure 5). The sensitivity of picking up the bone density was high in estimation of lumbosacral spine as compared to the femoral neck region. One case of malabsorption syndrome was exclusively having osteopenia (10%) and others were found to be having osteoporosis (90%). The common positive ailments were found to be that of tuberculosis (40%), malabsorption (30%), kidney disease (10%), diabetes mellitus (10%) and worms infestations (10%) (Figure 4). Six were having

osteopenia (30%) and the ratio was equally distributed among both the sexes. Eleven (55%) the patients were having osteoporosis. Males were dominating in this group (72.7%) as compared to females (27.2%). Three (15%) were declared as of normal range. Given in details in Table 2. The detailed statistics of the patients had been.

	Total Patients	Percentage
Male	11	55
Female	9	45

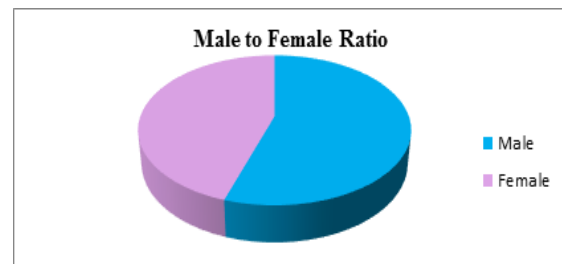


Figure 2: Male to female ratio of DEXA patients

	Normal	With ailments
Male Patients	3	8
Female Patients	7	2

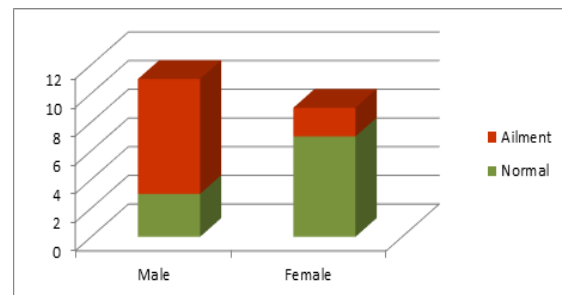


Figure 3: Distribution of normal to diseased patients with sex linkage.

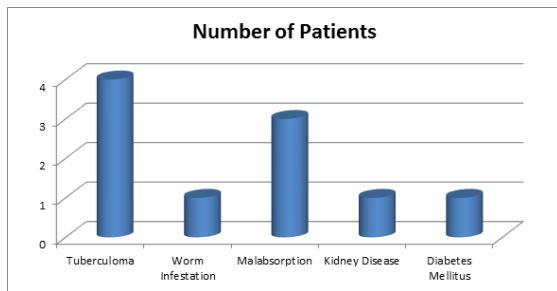
Patient No.	Weight (kg)	Height (cm)	Age (Years)
1	25	131	10
2	40	166	12
3	50	170	16
4	48	148	17
5	22	104	13
6	33	142	11
7	48	153	14
8	47	149	16
9	44	151	13
10	42	159	17
11	45	160	14
12	70	162	17
13	64	159	19
14	36	150	17
15	25	134	12
16	31	131	16
17	40	145	13
18	46	149	18
19	63	168	19
20	49	152	17

Average Weight = 43.4 kg  
Average height = 149.15 cm

Average Age =15.05 years

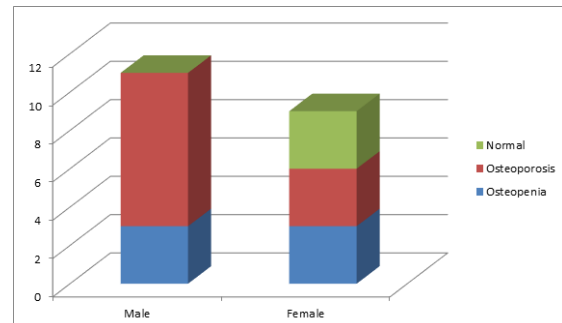
**Table 1: Detailed statistics of the patients included in the study**

S.No.	Ailment	Number of patients
1	Tuberculosis	4
2	Worm Infestation	1
3	Malabsorption	3
4	Kidney disease	1
5	Diabetes Mellitus	1



**Figure 4: Detailed of the ailments found in the group which was included in the study.**

	Male	Female
Osteopenia	3	3
Osteoporosis	8	3
Normal	0	3



**Figure 5: Male to female ratios of Osteopenia, Osteoporosis and Normal patients.**

**Table 2: Chart showing the details of all the pediatric DEXA cases during the period of Jan 2017-May 2017.**

S.No	Name	Age	Weight (Kg)	Height (Cm)	Complain	Region	Area (Cm <sup>2</sup> )	Bmc (G)	Bmd (G/Cm <sup>2</sup> )	T-Score	Z-Score	Remarks
1.	S	10/M	25	131	Multiple Cerebral Tuberculomas On ATT X 6 months	Spine L1-L4	35.28	14.17	0.402	-6.3	-6.3	Tuberculosis. On calcium supplement
						Femoral Neck	21.04	11.29	0.537	-3.3	-3.3	
2.	L	12/M	40	166	Mal absorption Syndrome	Spine L1-L4	52.49	37.92	0.722	-3.4	-3.4	On treatment with dietary regulation.
						Femoral Neck	30.60	26.53	0.867	-1.1	-1.1	
3.	S	16/M	50	170	Cervical Lymphadenopathy discharging sinus on left posterior auricular region	Spine L1-L4	49.82	43.82	0.880	-1.9	-1.9	Under Follow up
						Femoral Neck	32.66	33.55	1.027	0.0	0.0	
4.	N	17/F	48	148	Renal Calculus, No systemic Disease	Spine L1-L4	45.86	48.56	1.059	0.1	0.3	Normal Follow up
						Femoral Neck	24.27	20.83	0.858	-0.7	-0.7	
5.	D	13/F	22	104	Recurrent loose motions with mal absorption syndrome. On treatment	Spine L1-L4	35.08	19.71	0.562	-4.8	-4.8	Dietary control and calcium supplement
						Femoral Neck	26.99	20.04	0.743	-1.9	-1.9	
6.	D	11/M	33	142	Multiple mesenteric node with pain abdomen- 4-5 yrs	Spine L1-L4	35.30	19.67	0.557	-4.9	-4.9	.Tuberculosis On calcium supplement
						Femoral Neck	22.50	15.20	0.676	-2.4	-2.4	
7.	S	14/F	48	153	Pain Epigastric-2 yrs	Spine L1-L4	49.67	44.40	0.894	-1.4	-1.2	Normal Follow up
						Femoral Neck	28.39	26.82	0.945	0.0	0.0	
8.	M	16/F	47	149	Pain Abdomen (? Left Ureteric calculus)	Spine L1-L4	49.15	40.48	0.824	-2.0	-1.9	Normal Follow up
						Femoral Neck	29.32	22.24	0.759	-1.5	-1.5	
9.	U	13/F	44	151	Pain Abdomen- 2	Spine	49.66	38.7	0.781	-2.4	-2.3	Normal

					yrs	L1-L4	6				Follow up	
						Femor al Neck						
10.	S	17/M	42	159	Nephrotic syndrome	Spine L1-L4	50.90	34.20	0.672	-3.8	-3.8	On treatment
						Femor al Neck	38.03	31.37	0.825	-1.4	-1.4	
11.	R	14/M	45	160	Diabetes mellitus with subcenteric lymph nodes & Inadequate appetite – 1 months	Spine L1-L4	55.78	40.54	0.727	-2.9	-2.7	On treatment for juvenile DM
						Femor al Neck	36.20	32.82	0.907	-0.3	-0.3	
12.	R C	17/M	70	162	Mild Splenomegaly	Spine L1-L4	55.15	47.22	0.856	-1.7	-1.6	Normal Follow up
						Femor al Neck	45.14	44.94	0.996	0.4	0.4	
13.	R	19/F	64	159	Renal Stones	Spine L1-L4	56.25	50.57	0.899	-1.3	-1.2	Normal Follow up
						Femor al Neck	29.01	28.29	0.975	0.3	0.3	
14.	A	17/M	36	150	Recurrent loose motions anf pain abdomen	Spine L1-L4	42.67	28.74	0.674	-2.8	-1.8	On Follow up
						Femor al Neck	28.60	18.55	0.649	-2.0	-1.5	
15.	J	12/M	25	134	Multiple mesenteric lymph nodes are present, pain abdomen(epigastric)	Spine L1-L4	36.78	23.35	0.635	-4.1	-4.1	Tuberculosis on ATT and calcium supplement
						Femor al Neck	21.67	15.42	0.712	-2.1	-2.1	
16.	A	16/F	31	131	Pain abdomen ,Diagnosed as that of worms infestation	Spine L1-L4	27.69	18.16	0.656	-3.6	-3.3	On dietary and calcium supplement after anti-helminthic treatment
						Femor al Neck	19.11	15.64	0.819	-1.0	-1.0	
17.	N	13/M	40	145	Pain abd. With yellowish urine USG- Multiple subcentrimetric mesenteric lymph nodes	Spine L1-L4	42.93	28.17	0.656	-3.6	-3.4	Tuberculosis .on calcium supplement
						Femor al Neck	29.88	22.86	0.765	-1.5	-1.5	
18.	A	18/F	46	149	Rt. Lumbar region pain- 3-4 days	Spine L1-L4	54.42	50.17	0.922	-1.1	-1.0	Normal Follow up
						Femor al Neck	27.94	25.48	0.912	-0.2	-0.2	
19.	J	19/M	63	168	Dyspepsia with Malabsorption syndrome, USG- Cholelithiasis with chronic cholecystitis	Spine L1-L4	51.09	44.11	0.863	-2.1	-2.1	Under follow up
						Femor al Neck	33.86	27.53	0.813	-1.5	-1.5	
20.	N	17/F	49	152	Loss of appetite- 5-6 months	Spine L1-L4	54.92	58.53	1.066	0.2	0.3	Normal Follow up
						Femor al Neck	36.08	31.69	0.878	-0.5	-0.5	

### DISCUSSION

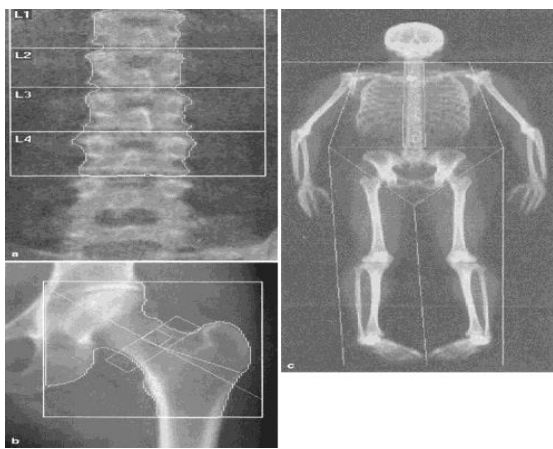
The evaluation by DEXA becomes more significant in following situations:  
When more than two long bone fractures present before 10 years of age.

When more than three fractures are present upto 19 years of age.

Lastly when Z score is >-2.0

Pediatric DEXA scan interpretation requires a great expertise because of the growing skelton. There are many other factors, like type of indication, volume

versus area, technical factors and protocol in newborns, to be kept in mind for the accurate results. Bone Mineral Density for the region of interest (ROI) is calculated by dividing the Bone Mineral Contents (BMC) in grams by Bone area (BA) in squared centimeters. This is always compared with the reference standard. BA of ROI is always taken in two dimensions comparing to the actual data which denotes three dimensional region [1]. The volume of the bone keeps on changing in the growing skeleton so the frequent follow ups are suggested [2]. Lumbar region and hip joints are selected for the scan. L1 to L4 vertebrae are properly centered with inclusion of minimal soft tissue. Hip joint should not have overlapping trochanters, neck and acetabulum regions.



**Figure 6: DEXA scan protocol. Lumbar spine (L1-L4) and hip joint should be centered as shown in the diagram.**

This also should not include any tubes, jewellery or any prosthetics. Adult algorithm always overestimates as BMD in pediatric patient is very low. Sometimes thoracic spine is included in the study and this is the best way to pick up collapsed vertebra [3,4]. Ashes bone is the real assessment of the BMC but it represents 7-9% of the bone ash value. There are variations due to wrong positioning and motion artifacts. Calibration is required with the phantom for the daily quality control scan. Least significant change (LSC) should be observed in follow up as per the age in 6-12 months. BMC and BA are closely related weight and height in the newborn [5,6].

There is strong indication for DEXA in children who are on corticoids for more than two months. The indication for other conditions like chronic inflammatory disease, hypogonadism, prolonged immobilization, low trauma fractures and where radiographs gives clue for osteoporosis. Few of the syndromes and genetic conditions also requires this evaluation like Ehlers-Danlos, Fibrous dysplasia, Homocystinuria, Hypophosphatasia, idiopathic hypercalciuria, Marfan's syndrome, osteogenesis imperfect and Menke's kinky hair syndrome.

In newborns it is area (aBMD) rather than volumetric data (vBMD) is more appropriate. Osteopenia and osteoporosis are defined as per WHO criteria if T-score  $< -1$  and  $< -2.5$  respectively. Z score in children show low mean BMD values as bone peak has yet to be achieved. In the report "low bone density" can be reported to avoid any confusion. This increase rapidly in puberty. Other dependent factors are ethnicity, gender, age and physiological maturity levels. These have to be compared with pediatric normative database. Gafni and Baron (2004) reported half of the cases of misdiagnosed osteoporosis as given by by T-score [7,8]. Tanner stage or gynecologic age have been included for the correct results. Crabtree et al (2004) proposed lean total body mass (LTM) algorithm in relation to height and BMC [9]. American college of Radiology and American college of Rheumatology recommend DEXA for the children but Society of Pediatric Radiology and American academy of Pediatrics have not cleared it so far. The radiation dose to the patient is negligible and even less than the normal background radiation dose (7 micro Sv). This has got no biological effect on the organs. Njhe et al (1997) had demonstrated that scatter dose is less than 1 micro mSv even the operator sitting at one meter distance without shielding. Thus annual dose for the operator is approximate 0.4 mSv with workload of sixteen patients per day [10].

## CONCLUSION

DEXA scan Z-scoring estimation is very sensitive method for diagnosing osteoporosis and osteopenia among pediatric age group. This is non invasive with minimal non-harmful radiation exposure. The incidence is slightly more among male sick patients as compared to the female group. The incidence has also been noticed higher among the patients who are on long term medication. This is useful in the chronic ailments like tuberculosis, diabetes mellitus, malabsorption syndrome and kidney diseases. This is helpful in preventing the risks of fractures among these vulnerable patients.

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### Consent

Written consent of the parents was taken before performing the DEXA scan test.



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