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COMPARATIVE EVALUATION OF RADIOGRAPHIC FEATURES OF JAWS AND TEETH ON OPG (ORTHOPENTAMOGRAM) IN THALASSEMIA MAJOR PATIENTS AND NORMAL INDIVIDUALS

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ABSTRACT

Introduction: The purpose of the present study is to make aware of serious disease, its radiographic features and its implications on dental care, especially for general dental practioners working in different communities.

Material and Methods: For the present study, 50 Thalassemia major patients of the age of 6 years and above as group I and 50 Age and Sex matched control subjects were selected as Group II.

Panoramic radiographs were taken using standard radiographic procedure on Orthopantomograph "**PLANMECA PM 2002 EC Proline"** Panoramic X-ray unit. Exposed Panoramic radiographs were processed manually. The processed radiographs were examined in subdued ambient light using transmitted light from a standard X-ray viewing box for radiographic features: spiky and short roots, enlargement of bone marrow spaces, thin lamina dura, identification of inferior alveolar canal, size of maxillary sinuses, taurodontism, and thickness of inferior mandibular cortex. Crown and root lengths were determined on panoramic radiographs by using Seow and Lai method.

Results and Conclusions: Thus, it can be concluded from the present study that the results of this study suggest that following radiographic signs are evidence of thalassemia major: small / absent maxillary sinuses, spiky and short roots, taurodontism, enlargement of bone marrow spaces, identification of inferior alveolar canal, thin lamina dura, inferior mandibular cortex. Radiographic findings described above on orthopantamogram are not pathognomonic in itself but may be used in the field of dentistry as a diagnostic aid for thalassemia major.

Keywords: thalassaemia, panoramic radiography, jaw, teeth.

INTRODUCTION

Thalassemia is a genetic disorder that involves the defective and decreased production of hemoglobin. Thomas B. Cooley, an American doctor, was the first person, who recognized and described β-thalassemia in 1925. The term "*Thalassemia*" was coined only in 1933 by G. Whipple and W. Bradford[1]. It is derived from the Greek words "*thalassa*" which means the sea and *"-haima*" the blood; so meaning "sea in the blood". Geographically the thalassemias are found in a broad belt extending from the Mediterranean basin to India and the orient.[1]

The purpose of the present study is to make aware of serious disease, its radiographic features and its implications on dental care, especially for general dental practioners working in different communities[2].

Radiological features of jaws and teeth include the appearance of spiky-shaped & short roots, taurodontism, attenuated lamina dura, enlarged bone marrow spaces, small maxillary sinuses, absence of inferior alveolar canal and thin cortex of mandible[3].

MATERIALS AND METHODS

For the present study, 50 Thalassemia major patients were selected from Department of Pediatrics, Medicine, Govt. Medical College & Hospital, Nagpur.

50 Age & Sex matched control subjects were selected from OPD of Oral Medicine & Radiology, Govt. Dental College & Hospital Nagpur which is situated in the same campus.

Inclusion criteria:

Group I: Thalassemia major patients of the age of 6 years & above.

Group II: Age & sex matched normal healthy individuals as controls.

A detailed case history was recorded & written consent of the patient / guardian of the patient for willingness to participate in the study was taken.

Panoramic radiographs:

Panoramic radiographs were taken using standard radiographic procedure on Orthopantomograph "PLANMECA PM 2002 EC Proline" Panoramic X-ray unit (Plate 1: fig-1). The unit was operated at 6-10 mA & 60-70 kVp (depending on patient) using KODAK T -MAT G films with Lanex regular intensifying screen (EASTMAN KODAK COMPANY, Rochester, New York). Exposed Panoramic radiographs were processed manually. The processed radiographs were examined in subdued ambient light using transmitted light from a standard X-ray viewing box for following radiographic features:-

i. Spiky and short roots
ii. Enlargement of bone marrow spaces
iii. Thin lamina dura
iv. Identification of inferior alveolar canal
v. Size of maxillary sinuses
vi. Taurodontism
vii. Thickness of inferior mandibular cortex

In this study, spiky roots, enlargement of bone marrow spaces, thin lamina dura, identification of inferior alveolar canal & size of maxillary sinuses were determined by visual perception comparing with control.

Molar teeth were investigated for taurodontism as this was one of the findings noted by Tulensalo et al[2]. A tooth was classified as taurodontic when the distance between the baseline connecting the mesial and distal points of the cementoenamel junction and the highest point of the floor of the pulp chamber reached or exceeded 3.5 mm^2.

The thickness of the inferior mandibular cortex in the molar region was defined as the distance between the inferior and superior borders of the cortex. Measurements were made using an electronic digital sliding caliper. The average of right & left side measurements were taken. All measurements were made three times by one examiner; the average was taken for the study. [2]

Crown and root lengths were determined on panoramic radiographs by using Seow & Lai method. For determining the crown and root lengths, the mandibular first permanent molar was selected because the amount of distortion in panoramic radiograph of this tooth is known to be minimal. The method of Seow and Lai is as follows: Briefly, the outlines of the mandibular first molars were transferred to an acetate tracing paper using a sharp pencil *rotring Tikky* (2B, 0.35 mm) (Plate 1: fig-2). A line representing the long axis of the tooth was then drawn from the deepest pit traced and running through the furcation area. The crown length was determined by measuring the distance from the deepest occlusal pit to the furcation area along the long axis drawn. The root length was determined from the furcation area to the tip of the longer root along the long axis drawn before. Roots which were shorter by 2mm or more than the average root length in control group were considered as short roots[2].

For the purpose of comparison and to determine the validity of the findings obtained from examining the panoramic radiographs of the study subjects, a total of 50 panoramic radiographs of the age and sex matched control group were taken from the Department of Oral Medicine & Radiology and reviewed under the same conditions.

To determine interobserver reliability in evaluation of above parameters the radiographs were evaluated by two experienced Oral Radiologists independently one of them interpreted the radiographs twice with two weeks interval between the two observations & intraobserver variability is determined.

The data obtained were analysed using the software, Statistical Package for the Social Sciences (SPSS) for Windows (Chicago, IL). Differences in radiological changes between the thalassaemic patients and control groups were tested using Chi-square (χ^2) test. Differences in crown length, root length between the two groups were tested using the independent *t*-test. A statistically significant difference was considered to be present when p-values were less than 0.05.

Statistical analysis

Statstical analysis of the data was done using Statistical Package for the Social Sciences (SPSS Version10.0)

1. The Chi square test was used to compare the frequency of radiographic features in group I & groups II.
2. Student's unpaired t-test was used to compare the measurements of group I & group II
   Level of significance was judged by p-value. For statistical significance $p<0.05$ was considered.
3. Kappa index was used to determine the interobserver & intraobserver variation.

RESULTS

In the present study, Group I consisted 50 patients of thalassemia major while Group II consisted of 50 normal ages & sex matched with Group I, healthy individuals.

Table 1 show that 29 (58%) patients had spiky & short roots in group I whereas 7 (14%) patients had spiky & short roots in group II. Difference in frequencies of spiky & short roots between group I & group II using Chi Square test was found to be statistically highly significant($p \leq 0.001$). (plate: 2 fig 3a, 3b)

Table 2 shows, 27 (54%) patients had enlargement of bone marrow spaces in group I whereas none (0%) of patients had enlargement of bone marrow spaces in group II. Difference in frequencies of enlargement of bone marrow spaces between group I & group II using Chi Square test was found to be statistically highly significant($p \leq 0.001$) (Plate:3 fig 4a, 4b).

Table 3 shows 20 (40%) of patients had thin lamina dura in group I whereas none (0%) the patients had thin lamina dura in group II. Difference in frequencies of thin lamina dura in group I & group II using Chi Square test was found to be statistically highly significant ($p \leq 0.001$) Plate:5 fig 6a, 6b).

Table 4 shows that inferior alveolar canal was identified in 27 (54%) of patients in group I whereas inferior alveolar canal could identify in 49 (98%) of patients in group II. Comparison of frequencies of identification of inferior alveolar canal in group I & group II using Chi Square test revealed the difference to be statistically highly significant ($p \leq 0.001$) (Plate:5 fig 6a, 6b).

Table 5 shows absence of maxillary sinuses in 5 (10%) patients, small maxillary sinuses in 28 (56%) in group I whereas in group II, 1 (2%) patient had small maxillary sinus. Difference in frequencies of small/absent maxillary sinuses between group I & group II using Chi Square test was found to be statistically highly significant ($p \leq 0.001$) (Plate: 4 fig 5a, 5b).

Table 6 shows that 28 (56%) patients had taurodontism in group I whereas 11 (22%) patients had taurodontism in group II. Difference in frequencies of taurodontism in between group I & group II using Chi Square test was observed to be statistically highly significant ($p \leq 0.001$)

Table 7 shows Mean thickness of inferior mandibular cortex in group I was 2.995 mm with a standard deviation of ± 0.860 mm whereas the mean thickness of inferior mandibular cortex in group II was 3.821 mm with a standard deviation of ± 1.024 mm. Comparison of the mean thickness of inferior mandibular cortices in group I & group

II using t- test revealed the difference of means to be statistically highly significant ($p \leq 0.001$)

Table 8 shows the mean crown length (CL) was 9.863 mm with a standard deviation of ± 0.955 mm in group I whereas the mean crown length (CL) was 10.287 mm with a standard deviation of ± 0.913 mm in group II. Comparison of the mean crown lengths (CL) in group I & group II using t-test revealed the difference of means to be statistically significant ($p \leq 0.05$).

Table 9 shows the mean root length (RL) was 11.157 mm with a standard deviation of ± 2.0857mm in group I whereas the mean root length (RL) was 12.402 mm with a standard deviation of ± 1.591 mm group II. Comparison of the mean root lengths (RL) in group I & group II using t- test revealed the difference of means to be statistically significant ($p \leq 0.05$).

DISCUSSION

Hemoglobinopathies are the most common autosomal recessive inherited diseases in humans. One of these important & more prevalent hemoglobinopathies is thalassemia major. Based on their clinical and genetic orders thalassemia majors are classified mainly into major (homozygous), intermedia, & minor (heterozygous) types. Thalassemia major is the most severe form of congenital hemolytic anemia[4].

The frequency of thalassemia major gene in Indian population varies between 0-17 percent. Its prevalence is high among Gujratis, Punjabis, Sindhis, Lohanas, and Bengalis.[5]

Radiological features in jaws and teeth include the appearance of spiky-shaped & short roots, taurodontism, attenuated lamina dura, enlarged bone marrow spaces, small maxillary sinuses, absence of inferior alveolar canal, and thin cortex of mandible.[2,3]

The aim of this study was to compare the radiographic changes in jaws and the crown & root lengths of the mandibular 1st permanent molars of thalassemia major patients with age and sex matched controls.

This case-control study consisted of 50 thalassemia major patients (Group-I) & 50 normal age & sex matched healthy individuals as controls (Group-II).

Age distribution in the present study ranged from 6 to 30 years with mean age of 14.34 ± 5.83 years for Group-I and Group- II (Table 1).Most patients with thalassemia major die between 2nd & 3rd decades of life[6].

The available literature suggests that the disease has no sex predilection. De Mattia D[7]observed sixty patients (31 males & 29 females) having thalassemia major. Hattab FH et al[8] studied dental casts of 46 thalassemic subjects, 25 males & 21 females with nearly equal sex distribution. Present study population comprised of 34 males & 16 females in each group.

In the study of Poyton[9] found out of sixteen cases, nine cases showed spiky & short roots. Hazza'a AM et al [2] found spiky roots in 13 (49.9%) thalassemia major patients, and only 4 (9.5%) radiographs of the control group showed this variation.

Spiky & short roots may be due to severe anemia, genetic & environmental factors such as endocrine dysfunction & stomatomedin deficiency which affect the tooth size in thalassemia major as a part of their general effect on growth retardation.[2]

Worth HM[10] described that trabeculae in both jaws are reduced in number and those which remain shows less density or less well seen. Poyton HG et al[9] seen large bone marrow spaces & pronounced trabeculae in seven of their cases and it showed such a definite picture that it was considered to be an important radiographic consideration. According to Hes Jan et al[11], Dis van ML the alveolar bone of upper & lower jaws showed a generalized rarefaction, thinning of cortical bone, and chicken wire appearance of enlarged marrow spaces with coarse trabeculation[10].

In group I, 20 (40%) patients had thin lamina dura whereas In group II, none (0%) of the patients had thin lamina dura, This finding was comparable with Hazza'a AM et al[2], in which thin lamina dura

was identified in 23 (46%) thalassemic patients whereas only 3 (6.0%) radiographs of the control group showed this radiographic feature. A statistically highly significant difference (p=0.000) was found between the thalassemic and the control groups. Worth HM [10], Poyton HG et al[9], Lauren L. Patton[3] also observed similar findings in thalassemia major patients.

In group I, in 27 (54%) patients, inferior alveolar canal were identified compared with 49 (98%) patients in group II. Complete absence of inferior canal noticed in 23 (46%) patients in group I compared with 1 (2%) subjects in group II. Comparison between group I & group II using Chi Square test was found to be statistically highly significant ($p \leq 0.001$). This finding was comparable with Hazza'a AM et al[2], in which 9 (18%) patients demonstrated inferior alveolar canal in thalassemia major patients whereas 33 (66%) were noticed with complete absence of inferior alveolar canal. Lauren L Patton[3]also observed similar findings in thalassemia major patients.

In group I, 28 (56%) patients had small maxillary sinuses, whereas in 1 (2%) had small maxillary sinus in group II. This finding is comparable with Hes Jan et al[11], who found that maxillary sinus was partially obliterated & there was hardly any pneumatization of paranasal sinuses. Cannell H[12] found bony deposition over the area of the maxillary antra. Poyton HG et al[9] and Hazza'a AM et al[2] observed small maxillary sinuses. This finding may be attributed to the bone marrow expansion causing hyperplasia of alveolar processes of the maxilla at the expense of normal volume sinuses**.**[2]

Taurodontism has been reported to affect principally molars & premolars in both the deciduous & permanent dentitions.[13] It is usually diagnosed through radiographic examination. it occurs generally association with certain syndromes & dental developmental disorders such as hypodontia, amelogesis & dentinogenesis imperfecta, ectodermal dysplasia syndrome & Down's syndrome. The etiology of taurodontism is still uncertain but it is thought to be caused by the failure of Hertwig's sheath to invaginate at the proper horizontal level but other possible etiologies have to be considered including spontaneous mutation and the influence of additional factors such as infection of developing tooth[13]. Hazza'a AM et al[2] noticed taurodontism in 17 (34%) thalassemia major patients compared with 4 (8%) controls. A significant difference was observed between the two groups (p=0.001**).** Our finding is comparable with the finding of Hazza'a AM et al.[2] It suggests that taurodontism can be one of the important features to be considered in thalassemia major.

In present study comparison of mean thickness of inferior mandibular cortex in groups I with group II using t- test revealed the statistically highly significant difference ($p = \leq 0.001$). Hazza'a AM et al[2] measured the thickness of the inferior border of the mandibular cortex in the area of permanent first molar. The difference in mean values between the two groups was statistically highly significant ($p \leq 0.001$). Soni NN, Barbee EF, Fergusion AD, Parrish BA[14] also revealed the attenuated & thin cortex in thalassemia major patients

Hazza'a AM et al[2] the mean crown length of the mandibular first molar of patients with thalassemia major was 9.58±0.83 mm (range 7.60–10.75 mm) compared with 10.45±0.78 mm (range 8.80–11.95 mm) of controls. A highly significant difference *(*p=0.000) was found between the mean crown length of the two groups.

Hazza'a AM et al.[2] In the study of Hazza'a AM et al[2] , the mean root length of the mandibular first molar of patients with thalassemia major was 11.89 ± 1.33 mm (range 9.90–15.37 mm) compared with 12.78 ± 1.67 mm (range 10.62–16.94 mm) for the control group. The difference in mean root values was statistically significant **(**p =0.032).

SUMMARY

The review of literature shows little literature on dental development in subjects with thalassemia major. Therefore, General Dental Practioners, especially those working in different communities & at different places in India, need to be aware of the nature of the disease, radiographic changes, course of the disease and its implications on dental care.

The findings of present study can be summarized as follows:

Following radiographic parameters were present in thalassemia patients compared to controls.

A) Parameters with highly significant differences ($p \leq 0.001$)

1. Size of Maxillary sinuses
2. Spiky & short roots
3. Taurodontism
4. Enlargement of bone marrow spaces
5. Inferior alveolar canal.
6. Thin lamina dura

B) Parameters with significant differences ($p \leq 0.05$)

1) Crown length (CL)

2) Root length (RL)

CONCLUSION

Thus, it can be concluded from the present study that the results of this study suggest following radiographic signs are evidence of thalassemia major: small / absent maxillary sinuses, spiky & short roots, taurodontism, enlargement of bone marrow spaces, identification of inferior alveolar canal, thin lamina dura, inferior mandibular cortex. Radiographic findings described above on orthopantamogram are not pathognomonic in itself but may be used in the field of dentistry as a diagnostic aid for thalassemia major.

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Table 1: Comparison of presence of spiky & short roots in Group I and Group II

	Spiky & Short Roots			**Chi Sq. test p-value**	**Result**
	Present	Absent	Total		
Group I	29 (58%)	21 (42%)	50	0.0000	HS
Group II	7 (14%)	43 (86%)	50		

HS: Highly significant

Table 2: Comparison of presence of enlargement of bone marrow spaces in Group I and Group II

	Enlargement of bone marrow spaces			**Chi Sq. test p-value**	**Result**
	Present	Absent	Total		
Group I	27 (54%)	23 (46%)	50	0.0000	HS
Group II	0 (0%)	50 (100%)	50		

Table 3: Comparison of presence of thin lamina dura in Group I and Group II

	Thin lamina dura			**Chi Sq. test p-value**	**Result**
	Present	Absent	Total		
Group I	20 (40%)	30 (60%)	50	0.0000	HS
Group II	0 (0%)	50 (100%)	50		

Table 4: Comparison of identification of inferior alveolar canal in Group I and Group II

	Identification of inferior alveolar canal			**Chi Sq. test p-value**	**Result**
	Present	Absent	Total		
Group I	27 (54%)	23 (46%)	50	0.0000	HS
Group II	49 (98%)	1 (2%)	50		

Table 5: Comparison of size of maxillary sinuses in Group I and Group II

	Size of maxillary sinuses			Chi Sq. test p-value	Result
	Small /Absent	Normal	Total		
Group I	28 (56%) 5 (10%)	17 (34%)	50	0.0000	HS
Group II	1 (2%), 00 (0%)	49 (98%)	50		

Table 6: Comparison of taurodontism in Group I and Group II

	Taurodontism			**Chi Sq. test p-value**	**Result**
	Present	Absent	Total		
Group I	28 (56%)	22 (44%)	50	0.0000	HS
Group II	11 (22%)	39 (78%)	50		

Table 7: Comparison of thickness of inferior mandibular cortex in group I and Group II

	Group	**n**	**Mean (mm)**	**Std. Deviation**	**Std. Error Mean**	**t-value**	**p-value**	**Result**
Thickness of inferior mandibular cortex	Group I	50	2.9958	± 0.8600	0.1216	4.364	0.0000	HS
	Group II	50	3.8212	± 1.0243	0.1449			

Table 8: Comparison of crown length (CL) in Group I and Group II

	Group	**n**	**Mean (mm)**	**Std. Deviation**	**Std. Error Mean**	**t- value**	**p- value**	**Result**
Crown length (CL)	Group I	48	9.8638	± 0.9555	0.1379	2.208	0.03	S
	Group II	47	10.2872	± 0.9130	0.1332			

S: Significant

Table 9: Comparison of root length (RL) in Group I and Group II

	Group	**n**	**Mean (mm)**	**Std. Deviation**	**Std. Error Mean**	**t-value**	**p-value**	**Result**
Root length (RL)	Group I	47	11.1579	± 2.0857	0.3042	3.252	0.002	S
	Group II	47	12.4023	± 1.5918	0.2322			

S: Significant

Plates: 1-5

PLATE 1

Fig. 1. PLANMECA PM 2002 EC Proline - Panoramic X-ray unit

Fig. 2. Electronic digital sliding vernier caliper, pencil (2B, 0.35 mm), scale

PLATE 2

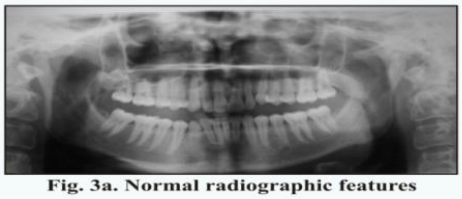

Fig. 3a. Normal radiographic features

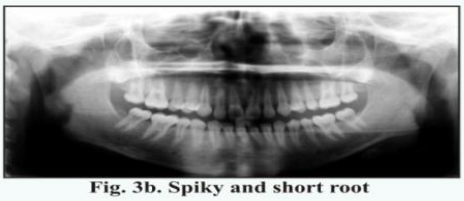

Fig. 3b. Spiky and short root

PLATE 3

Fig. 4a. Normal radiographic features

Fig. 4b. Enlarged bone marrow spaces, thin mandibular cortex

PLATE 4

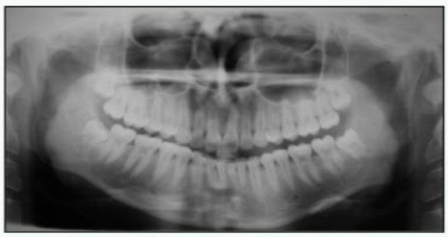

Fig. 5a. Normal maxillary sinuses

Fig. 5b. Absent maxillary sinuses

PLATE 5

Fig. 6a. Normal radiographic features

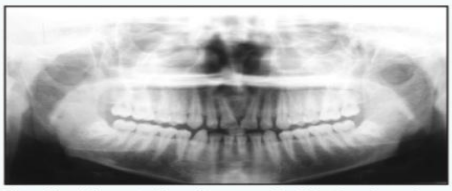

Fig. 6b. Absent alveolar canal, thin lamina dura