Australian Journal of Basic and Applied Sciences, 6(12): 464-473, 2012
ISSN 1991-8178

# Oro-Dental Manifestations in Different Types of Osteogenesis Imperfecta

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**Abstract: Purpose:** This study aimed at determining the characteristic oro-dental manifestations (ODMs) in patients with osteogenesis imperfecta (OI) in order to develop a therapeutic and follow up oro-dental management scheme. It also aimed at comparing the ODMs in Sillence different types of OI hoping to aid in the differential diagnosis. **Subjects and Methods:** This study was carried out on 49 Egyptian patients with OI. Diagnosis of each case was based on full history taking, three generation pedigree construction, clinical examination, and confirmative investigations. Cases were classified according to Sillence *et al.* (1979) into four types (I-IV), and the oro-dental examination was carried out. Then the data was collected, tabulated, and the descriptive statistics was performed in the form of percentages. **Results:** The results of this study revealed that the percentages of thick lower lip, high arched palate, long philtrum, highly attached labial frenum, thick upper lip, thick upper labial frenum, macroglosia, thick alveolar ridge, everted lower lip, prominent median palatine raphe (PMPR), enamel hypocalcification, bow upper shaped lip, long uvula, prominent premaxilla and dentinogenesis imperfecta (DI) were 57.1%, 53.1%, 49%, 46.9%, 44.9%, 32.6 %, 32.6 %, 30.6%, 28.6%, 28.6%, 26.5%, 24.5%, 24.5%, 22.4%, and 20.4%, respectively. The most common ODMs in the different studied OI types (I-IV) included: thick lower lip in 69% for type I, 50% for type III, and 55.5% for type IV. High arched palate was present in 76.9% for type I, 38.5% for type III, and 66.6% for type IV. Long philtrum was present in 30.8% for type I, 53.8% for type III, and 55.5% for type IV. The percentage of highly attached upper labial frenum was 38.4% for type I, 53.8% for type III, and 44.4% for type IV. Thick upper lip was present in 53.8% for type I, 38.5% for type III, and 55.5% for type IV. On the other hand the percentage of DI was 7.7% for type I, 26.9% for type III, and 22.2% for type IV. **Conclusion:** Although oro-dental examination should be routinely done in OI patients to detect and manage the common associated ODMs, it is difficult to differentiate between the Sillence different types of OI based on the clinical or radiographic features of ODMs.

**Key words:** Osteogenesis Imperfecta, orodental manifestations, egyptian patients,De novo mutations, hypocalcification.

## INTRODUCTION

Osteogenesis imperfecta (OI) occurs in about 1 in 20,000 births and is caused by quantitative and qualitative defects in the synthesis of collagen type I (Engelbert *et al. 1998*). It characterized by bone fragility, deformity of the spine and long bones, short stature, blue sclera, and dentinogenesis imperfecta (Lee *et al. 2006*).

The fragility of bone is due to low bone mass giving an increased fracture incidence. This fragility has led to the adoption of the trivial name of "brittle bone disease". The heritable nature of the disorder distinguishes it from idiopathic juvenile osteoporosis, although clinical osteoporosis is also a consequence of OI (Roughley *et al. 2003*).

Patients with OI do not have perturbations in serum calcium and vitamin D metabolite levels as a consequence of their disease, which distinguishes OI from osteomalacia. OI may present with other clinical features, but these are by no means universal. Such features include the presence of blue sclera, dentinogenesis imperfect (DI), skin hyperlaxity and joint hypermobility. These are all features that one might expect to be associated with a disorder involving type I collagen, though such a relationship is not absolute. While individuals with OI having blue sclera and dentinogenesis imperfecta commonly have mutations in one of their

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type I collagen genes, there are many patients with type I collagen gene mutations who do not exhibit these secondary characteristics. In addition, the OI patient may present with wormian bones in the sutures of the skull, and may be of decreased height and have skeletal deformities. Patients with OI usually suffer from frequent fractures and deformity of the long bones during development, resulting in impaired ambulation (Roughley *et al. 2003*, Enright and Noonan *2006*).

The majority of reported OI cases are caused by dominant mutations in type I collagen genes: COL1A1 (OMIM 120150) and COL1A2 (OMIM 120160). Tissues in which the principal matrix protein is type I collagen (mainly bone, dentin, sclerae, and ligaments) can be affected. The resultant abnormalities include blue sclera, rigidity of the osseous tissue, hearing loss, DI, growth deficiency, laxity of the joints, and any combination of these characteristics (Marini *2004*, and Cabral *et al. 2006*).

Using the Sillence classification, one can determine the type of OI based on clinical, radiographic, and genetic findings. According to the Sillence classification, the wide phenotypic variability of the disease is barely represented in the four clinical types I, II, III, and IV. There are extreme phenotypic variations within the OI population. Four types of OI including mild, perinatal lethal, progressive deforming, and moderately severe were classified according to clinical, genetic, and radiographic criteria. Each of the four types of OI is further subdivided on the basis of the absence or presence of dentogenesis imperfecta (Sillence *1988*).

However, many OI patients still cannot be easily assigned to any one of the 4 classes because of the broad spectrum and complexity of molecular abnormalities resulting in OI (Niyibizi *et al. 2000* ). New types V-X and XII have been added to the classification but have not been associated to collagen genes mutations (Rauch and Glorieux *2004*, and Venturi *et al. 2006*).

Some cases with OI display no abnormalities in the dentition, whereas others manifest significant dental involvement. Other oral manifestations associated with OI include midfacial hypoplasia, a shortened maxilla with normal mandibular length, class III malocclusion, and posterior crossbite (Isshiki 1966).

Dentinogenesis imperfecta (DI) is characterized clinically by opalescent and translucent dentine due to a mesenchymal defect. The primary teeth are more severely affected than is the permanent dentition. The color of the teeth varies from opalescent gray or brown to yellow, and both upper and lower dentitions are involved. Radiographically, the crowns of the teeth are bulbous with marked cervical constrictions, and pulp chambers become obliterated over a period of time (Barron *et al. 2008*).

In spite of that OI is a high risk genetic disorder and many studies (Falvo *et al.* 1974, Sillence *et al.* 1979, Helm *et al.* 1983, Schwartz and Tsipouras *et al.* 1984, Stenvik *et al.* 1985, Lukinmaa *et al.* 1987, Ranta *et al.* 1993, Luder and Steinman *et al.* 1996, Jensen and Lund 1997, Schuller and Holst *et al.* 1998, Lindau *et al.* 1999, Lund *et al.* 1998, O'Connell and Marini 1999, Kirkevang *et al.* 2001, Mahoney *et al.* 2001,Malmgren and Norgren 2002, Sanches *et al.* 2005, Gupte *et al.* 2006, Saeves *et al.* 2009, Milano *et al.* 2011, Scaramuzzo *et al.* 2011, Napierala *et al.* 2012, and Opsahl *et al.* 2012 ) had been carried out; it should be emphasized that till now up to our knowledge the available literature does not present a complete coverage of different oro-dental manifestations of this disease. So this study aimed at determining the characteristic ODMs in patients with OI in order to develop a therapeutic and follow up oro-dental management scheme. It also aimed at comparing the oro-dental manifestations in Sillence different types of osteogenesis imperfecta hoping to aid in the differential diagnosis.

***Subjects and Methods:***

The study was carried out on 49 Egyptian patients with OI (20 males and 29 females). All cases were recruited from the Limb Malformations and Skeletal Dysplasia Clinic (LMSDC), Medical Services Unit (MSU), National Research Centre (NRC). They were diagnosed at LMSDC, MSU, NRC. Diagnosis was based on full history taking, three generation pedigree construction and clinical examination including dysmorphic features, skeletal system and other body systems. Confirmative investigations included radiological examination, bone densitometry (DEXA), serum levels of calcium, phosphorous and alkaline phosphatase in addition to audiological assessment.

Cases were classified according to Sillence *et al.* (1979) into four types (I-IV) as follows: ***Type I:*** A dominant mild form with blue sclera and no or mild deformity. ***Type II:*** A perinatally lethal OI syndrome with blue sclera, multiple fractures and deformities at birth. ***Type III:*** A progressively deforming severe form with blue sclera (normalizes with age)**.** ***Type IV:*** A dominant moderate form with normal sclera and deformities.

Oro-dental examination was carried out at Oro-Dental genetics clinic, NRC, according to the Oro-Dental Genetics Department's Examination Chart. The examination data was collected and included the examination date, chief complaint, onset of the condition, reason for referral, and referral clinic. Oro-Dental examination included the related facial structures (Cheek-Chin-others). Extra-oral structures were studied to investigate the pre-maxilla, maxilla, and mandible, philtrum, upper lip, and lower lip. The intra-oral structures (the mouth and the dental structures) were examined. Then the data was collected and tabulated, the descriptive statistics was performed in the form of percentages.

***Results:***

Forty nine patients with OI including 20 males and 29 females were classified according to Sillence[33] classification***;*** 13 cases were consistent with OI type I, 26 cases with type III, 9 cases with type IV. Only one case was consistent with type II as most OI cases with type II-OI die early in life.

Results of pedigree analysis of the studied patients revealed that twenty two were the offspring of consanguineous parents (44.9%). Nine patients have an affected parent (18.36%). Similarly affected sibs were recorded in 12 cases (24.5%). Twenty eight patients were denovo (57.1%).

The ODMs in patients with OI types I, III and IV are shown in table 1. The only patient with OI type II had prominent premaxilla, long philtrum, thick lower lip, lower pseudo labial cleft, thick alveolar ridge, macroglossia, prominent median palatine raphe, narrow vault palate and wide pulp chamber.

Examples of manifestations in the studied OI patients are shown in Figs. 1-4. The most common ODMs in the studied patients included: Thick lower lip in 28 patients (57.1%), high arched palate in 26 patients (53.1%), long philtrum and highly attached upper labial frenum in 23 patients (46.9%) and thick upper lip in 22 patients (44.9%). Less than one third of the patients had thick upper labial frenum and macroglossia (32.6 %), thick alveolar ridge (30.6%), everted lower lip and prominent median palatine raphe (PMPR) (28.6%), enamel hypocalcification (26.5%), bow shaped upper lip and long uvula (24.5%), prominent premaxilla (22.4%) and dentinogenesis imperfecta (20.4%). Less frequent ODMs included: open bite and spacing in 9 patients each (18.4%), enamel hypoplasia in 8 patients each (16.3%), lower pseudo labial cleft in 7 patients each (14.28%), short philtrum, bifid tip (tongue), mandibular macrognathia, and shallow palate in 6 patients each (12.2%). Prominent philtrum, microstomia, everted upper lip, wide over jet, and malocclusion were present in 5 patients each (10.2%). ODMs present in less than 10% of cases included: flat philtrum, fissured upper lip, fissured lower lip, geographic tongue, deep over bite, and diastima (8.2% each), pointed chin, and macrostomia (6.1% each), maxillary micrognathia, double chin, partial ankyloglossia, attrition, edge to edge, class III, narrow vault, wide pulp chamber and crowding of teeth (4.1% each), broad philtrum, bow shaped lower lip, thin lips, bifid uvula, short uvula, V- shaped palate, early eruption, malposed teeth, missing teeth, posterior cross bite, flaring of lower anterior teeth, microdontia, and macrodontia (2.04% each). On the other hand, mandibular micrognathia, dislocation of TMJ, upper pseudo labial cleft, fissured tongue, delayed eruption, class II were not present in any of the studied cases (Fig. 5).

The percentage of thick lower lip in OI patients was 69% for type I, 50% for type III, and 55.5% for type IV. High arched palate was present in 76.9% for type I, 38.5% for type III, and 66.6% for type IV. The percentage of long philtrum in OI patients was30.8% for type I, 53.8% for type III, and 55.5% for type IV. Highly attached upper labial frenum in OI patients was present in 38.4% for type I, 53.8% for type III, and 44.4% for type IV. The frequency of thick upper lip in OI patients was 53.8% for type I, 38.5% for type III, and 55.5% for type IV. While the percentage of DI in OI patients was 7.7% for type I, 26.9% for type III, and 22.2% for type IV.

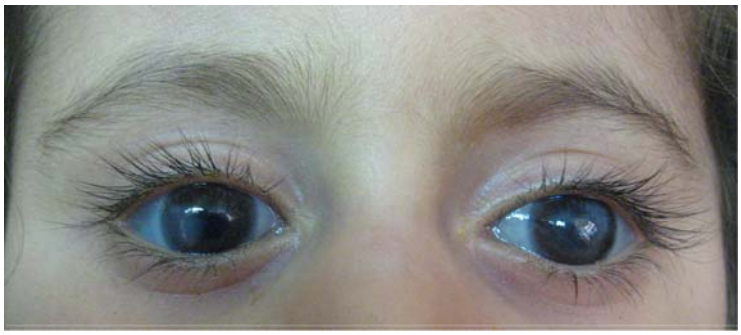

**Fig. 1:** OI type III patient with blue sclera.

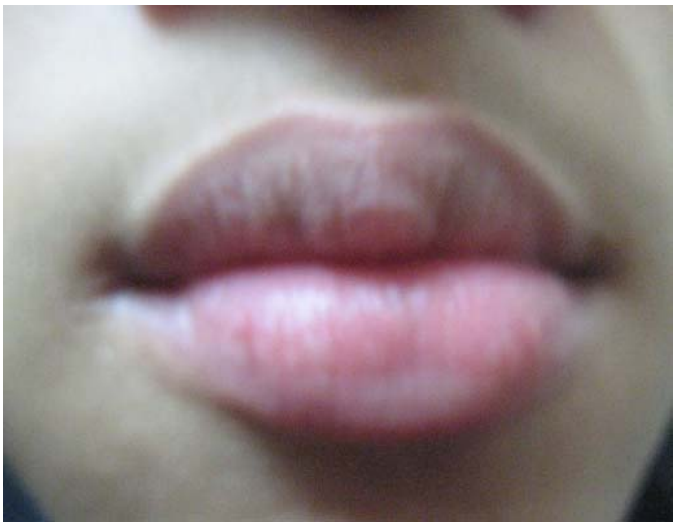

**Fig. 2:** Thick and fissured lips, and everted lower lip in OI patient type III.

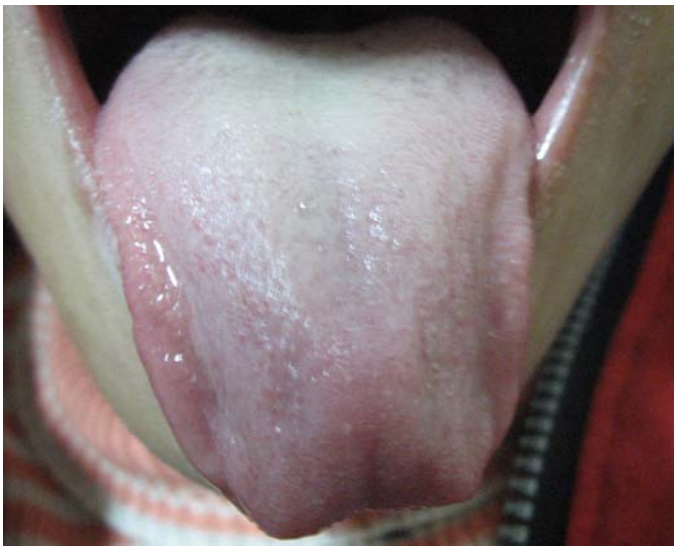

**Fig. 3:** Macroglossia in OI patient type I.

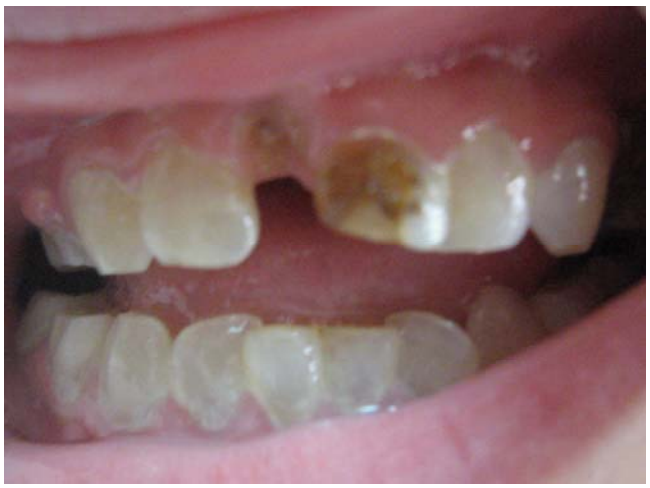

**Fig. 4:** Opalescent dentin in OI patient type III.

**Table 1:** Oro-dental manifestations (ODMs) in OI cases types I, II, III, and IV.

| Type | Type I (no. 13) | | Type III (no. 26) | | Type IV (no. 9) | | Total Including 1 case with type II (no. 49) |
|---|---|---|---|---|---|---|---|
| ODMs | Freq. | Percent | Freq. | percent | Freq. | percent | No.(percentage) |
| Related facial area | | | | | | | |
| Prominent premaxilla | 2/13 | 15.4 % | 5/26 | 19.2% | 3/9 | 33.3% | 10+1/49 (22.4%) |
| Max. Micrognathia | 0/13 | 0% | 1/26 | 3.8% | 1/9 | 11.1% | 2/49 (4.1%) |
| Mand.Micrognathia | 0/13 | 0% | 0/26 | 0% | 0/9 | 0% | 0/49 (0%) |
| Mand. Macrognathia | 2/13 | 15.4% | 2/26 | 7.7% | 2/9 | 22.2% | 6/49 (12.2%) |
| Dislocation of TMJ | 0/13 | 0% | 0/26 | 0% | 0/9 | 0% | 0/49 (0%) |
| Pointed Chin | 2/13 | 15.4% | 1/26 | 3.8% | 0/9 | 0% | 3/49 (6.1%) |
| Double chin | | 0% | 2/26 | 7.7% | 0/9 | 0% | 2/49 (4.1%) |
| Mouth abnormalities | | | | | | | |
| Long philtrum | 4/13 | 30.8% | 14/26 | 53.8% | 5/9 | 55.5% | 23+1/49 (49%) |
| Prominent Philtrum | 1/13 | 7.7% | 4/26 | 15.4% | | 0% | 5/49 (10.2%) |
| Broad philtrum | 1/13 | 7.7% | | 0% | 0/9 | 0% | 1/49 (2.04%) |
| Short philtrum | 2/13 | 15.4% | 2/26 | 7.7% | 2/9 | 22.2% | 6/49 (12.2%) |
| Flat philtrum | 0/13 | 0% | 3/26 | 11.5% | 1/9 | 11.1% | 4/49 (8.16%) |
| Microstomia | 0/13 | 0% | 5/26 | 19.2% | 0/9 | 0% | 5/49 (10.2%) |
| Macrostomia | 0/13 | 0% | 2/26 | 7.7% | 1/9 | 11.1% | 3/49 (6.1%) |
| Lip | | | | | | | |
| Thick upper lip | 7/13 | 53.8% | 10/26 | 38.5% | 5/9 | 55.5% | 22/49 (44.9%) |
| Thick lower lip | 9/13 | 69.2% | 13/26 | 50% | 5/9 | 55.5% | 27+1/49 (57.1%) |
| Everted upper lip | 1/13 | 7.7% | 4/26 | 15.4% | 0/9 | 0% | 5/49 (10.2%) |
| Everted lower lip | 6/13 | 46.1% | 5/26 | 19.2% | 3/9 | 33.3% | 14/49 (28.57%) |
| Bow shaped upper lip | 5/13 | 38.4% | 6/26 | 23% | 1/9 | 11.1% | 12/49 (24.49%) |
| Bow shaped lower lip | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1/49 (2.04%) |
| Thin lips | 0/13 | 0% | 0/26 | 0% | 1/9 | 11.1% | 1/49 (2.04%) |
| Fissured upper lip | 1/13 | 7.7% | 2/26 | 7.7% | 1/9 | 11.1% | 4/49 (8.16%) |
| Fissured lower lip | 1/13 | 7.7% | 2/26 | 7.7% | 1/9 | 11.1% | 4/49 (8.16%) |
| Upper pseudo labial cleft | 0/13 | 0% | 0/26 | 0% | 0/9 | 0% | 0/49 (0%) |
| Lower pseudo labial cleft | 2/13 | 15.4% | 4/26 | 15.4% | 0/9 | 0% | 6+1/49 (14.28%) |
| Oral region abnormalities | | | | | | | |
| Thick upper labial frenum | 2/13 | 15.4% | 11/26 | 42.3% | 3/9 | 33.3% | 16/49 (32.6%) |
| Highly attached upper labial frenum | 5/13 | 38.4% | 14/26 | 53.8% | 4/9 | 44.4% | 23/49 (46.9%) |
| Thick alveolar ridge | 0/13 | 0% | 14/26 | 53.8% | 0/9 | 0% | 14+1/49 (30.6%) |
| Tongue | | | | | | | |
| Macroglossia | 1/13 | 7.7% | 9/26 | 34.6% | 5/9 | 55.5% | 15+1/49 (32.6%) |
| Partial ankyloglossia | 2/13 | 15.4% | 0/26 | 0% | 0/9 | 0% | 2/49 (4.1%) |
| Bifid tip (tongue) | 1/13 | 7.7% | 5/26 | 19.2% | 0/9 | 0% | 6/49 (12.2%) |
| Fissure tongue | 0/13 | 0% | 0/26 | 0% | 0/9 | 0% | 0/49 (0%) |
| Geographic | 0/13 | 0% | 3/26 | 11.5% | 1/9 | 11.1% | 4/49 (8.16%) |
| Palate | | | | | | | |
| High arched palate | 10/13 | 76.9% | 10/26 | 38.5% | 6/9 | 66.6% | 26/49 (53.1%) |
| Prominent median palatine raphae (PMPR) | 2/13 | 15.4% | 9/26 | 34.6% | 2/9 | 22.2% | 13+1/49 (28.57%) |
| Narrow vault | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1+1/49 (4.1%) |
| Bifid uvula | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1/49 (2.04%) |
| Long uvula | 2/13 | 15.4% | 9/26 | 34.6% | 1/9 | 11.1% | 12/49 (24.48%) |
| Short uvula | 0/13 | 0% | 1/26 | 3.8% | 0/9 | 0% | 1/49 (2.04%) |
| V-shaped palate | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1/49 (2.04%) |
| Shallow palate | 0/13 | 0% | 5/26 | 19.2% | 1/9 | 11.1% | 6/49 (12.2%) |
| Teeth | | | | | | | |
| Delayed eruption | | 0% | 0/26 | 0% | 0/9 | 0% | 0/49 (0%) |
| Early eruption | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1/49 (2.04%) |
| Enamel hypoplasia | 1/13 | 7.7% | 6/26 | 23% | 1/9 | 11.1% | 8/49 (16.3%) |
| Enamel hypo-calcification | 4/13 | 30.8% | 8/26 | 30.7% | 1/9 | 11.1% | 13/49 (26.5%) |
| Dentinogensis Imperfecta (DI) | 1/13 | 7.7% | 7/26 | 26.9% | 2/9 | 22.2% | 10/49 (20.4%) |
| Attrition | 0/13 | 0% | 2/26 | 7.7% | 0/9 | 0% | 2/49 (4.1%) |
| Malposed teeth | 0/13 | 0% | 0/26 | 0% | 1/9 | 11.1% | 1/49 (2.04%) |
| Missing teeth | 0/13 | 0% | 0/26 | 0% | 1/9 | 11.1% | 1/49 (2.04%) |
| Wide over jet | 2/13 | 15.4% | 2/26 | 7.7% | 1/9 | 11.1% | 5/49 (10.2%) |
| Deep over bite | 3/13 | 23% | 1/26 | 3.8% | 0/9 | 0% | 4/49 (8.1%) |
| Open bite | 1/13 | 7.7% | 8/26 | 30.7% | 0/9 | 0% | 9/49 (18.4%) |
| Posterior Cross bite | 0/13 | 0% | 0/26 | 0% | 1/9 | 11.1% | 1/49 (2.04%) |
| Spacing | 3/13 | 23% | 2/26 | 7.7% | 4/9 | 44.4% | 9/49 (18.4%) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Diastima | 2/13 | 15.4% | 0/26 | 0% | 2/9 | 22.2% | 4/49 (8.16%) |
| Malocclusion | 0/13 | 0% | 5/26 | 19.2% | 0/9 | 0% | 5/49 (10.2%) |
| Flaring of lower anterior | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1/49 (2.04%) |
| Edge to edge | 0/13 | 0% | 0/26 | 0% | 2/9 | 22.2% | 2/49 (4.1%) |
| Class II | 0/13 | 0% | 0/26 | 0% | 0/9 | 0% | 0/49 (0%) |
| Class III | 0/13 | 0% | 2/26 | 7.7% | 0/9 | 0% | 2/49 (4.1%) |
| Crowding | 0/13 | 0% | 2/26 | 7.7% | 0/9 | 0% | 2/49 (4.1%) |
| Microdontia | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1/49 (2.04%) |
| Macrodontia | 0/13 | 0% | 0/26 | 0% | 1/9 | 11.1% | 1/49 (2.04%) |
| Wide pulp chamber | 1/13 | 7.7% | 0/26 | 0% | 0/9 | 0% | 1+1/49 (4.1%) |

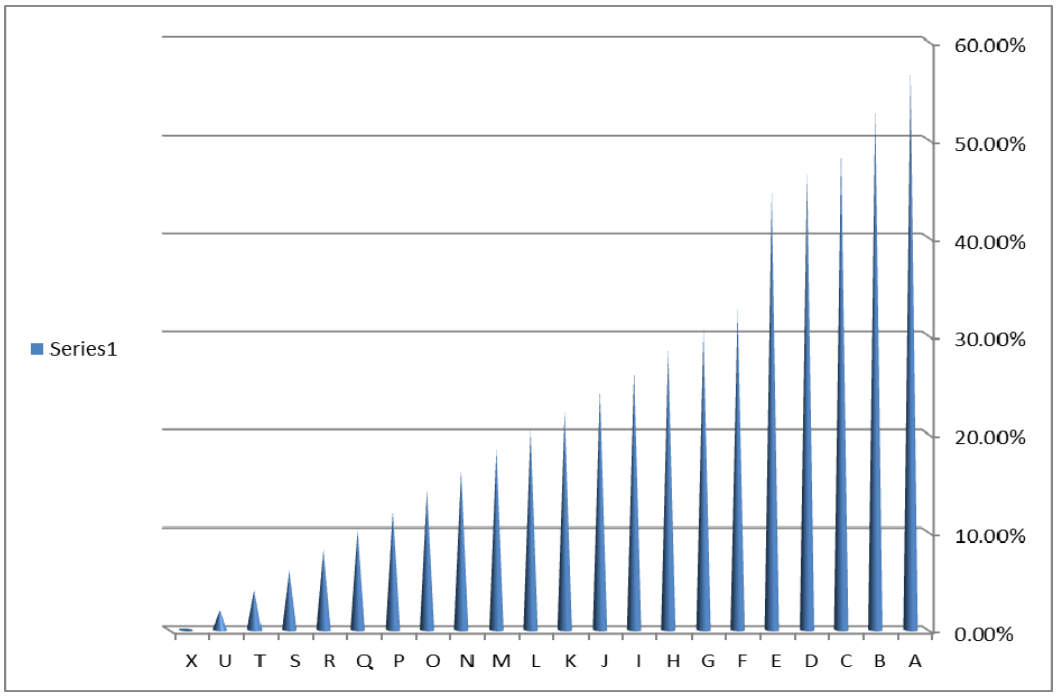


**Fig. 5:** Percentages of Oro-dental manifestations in OI patients.

A = Thick lower lip. B=High arched palate. C=Long philtrum. D =Highly attatched labial frenum. E =Thick upper lip. F=Thick upper labial frenum, and Macroglossia. G=Thick alveolar ridge. H=Everted lower lip, and PMPR. I=Enamel hypocalcification. J=Bow upper shaped lip, and Long uvula. K=Prominent premaxilla. L= Dentinogenesis imperfecta. M=Open bite, and Spacing. N=Enamel hypoplasia. O= Lower pseudo labial cleft. P=Short philtrum , Mand. Macrognathia, Bifidtip(tongue), and Shallow palate. Q=Prominent philtrum, Microstomia, Everted upper lip, Wide over jet, and Maloclusion. R=Flat philtrum, Fissured upper lip, Fissured lower lip, Geographic(tongue), Deep over bite, and Diastima. S= Pointed chin, and Macrostomia. T=Max.Micrognathia, Double chin, Partial ankyloglossia, Attrition, Edge to edge, Class III, Crowding, Narrow vault, and Wide pulp champer. U= Broad philtrum, Bow lower shaped lip, Thin lips, Bifid uvula, Short uvula, Early eruption, Short uvula, Early eruption, Malposed teeth, Missing teeth,Cross bite, Flaring of lower anterior teeth, Microdontia, and Macrodontia. X=Mand.micrognathia, Dislocation of TMJ, Upper pseudo labial cleft, Fissured tongue, V- shaped palate, Delayed eruption, and Class II.

***Discussion:***

An attempt to evaluate and assess the ODMs of OI had been carried out on 49 patients. All cases were Egyptian patients diagnosed at the LMSDC, Medical Services Unit, NRC. Male to female ratio was 20:29 with a slight female predominance; this was also reported by Elhossini *2009.* Patients were classified according to Sillence *et al.* (1979) into four types (I-IV). Type III was the most common type in this study consistent with other studies (O'Connell and Marini 1999, *and* Elhossini 2009). In this study there was only one case with OI type II who died at the first months of life as this type is the most severe perinatally lethal form of the disease.

Most patients with OI follow an autosomal dominant pattern of inheritance. Paternal age effect for increased risk of new mutations has been documented (Blumsohn *et al.* 2001). Studies of the clinically unaffected parents in some families, who had more than one child with dominant OI, have shown that the cause of the occurrence is parental germ line mosaicism. Clinically, the mosaic carriers are normal or minimally

affected. They are most often identified by having more than one child with the fully manifesting heterozygous condition (Cabral and Marini 2004).

In this study parental consanguinity was present in 22 patients. Twenty eight patients were the result of denovo mutations. Parental age above 35 years at the time of child birth was present in 17 cases, while history of exposure to an environmental hazard (as chemical exposure or X-rays exposure) was present in 22 cases. Similarly affected parent was present in 9 cases indicating AD inheritance. Similarly affected sibs were recorded in 12 cases.

AR inheritance was confirmed by molecular studies in 8 patients, offspring of consanguineous parents with similarly affected sibs in 4 patients. Consanguinity with history of similarly affected sibs in 3 cases but no proved mutation in the known AR-OI causing genes indicates the possibility of germ line mosaicism or the presence of unidentified AR-OI causing genes. One patient, offspring of non-consanguineous parents with history of similarly affected sibs raises the possibility of germ line mosaicism.

The Oro-dental examination was carried out according to the Oro-Dental Genetics Department's examination chart at NRC. The highest frequency of ODMs in this study was that of thick lower lip in 57.1% of cases (69% for type I, 50% for type III, and 55.5% for type IV) and high arched palate which was present in 53.1% of cases (76.9% for type I, 38.5% for type III, and 66.6% for type IV). Also the percentage of long philtrum in OI cases was 49% (30.8% for type I, 53.8% for type III, and 55.5% for type IV). In spite of the high frequency of the pervious oro-dental manifestations there was difficulty in differentiating between the different types of osteogensis imperfecta based on the pervious clinical manifestations (thick lower lip, high arched palate, and long philtrum).

The percentage of prominent premaxilla, mandibular macrognathia, maxillary micrognathia, and mandibular micrognathia in osteogensis imperfecta cases of this study were 22.4%, 12.2%, 4.1%, and 0%, respectively, these were in disagreement with Isshiki (1966) who reported midface hypoplasia and a shortened maxilla in osteogensis imperfecta. However, the abscence of mandibular micrognathia in the studied cases was in agreement with Isshiki (1966).

The oral manifestations in OI cases of this study that are related to the tongue as macroglossia, partial ankyloglossia, bifid tip (tongue), fissure tongue, geographic tongue were present in 32.6%, 4.1%, 12.2%, 0%, and 8.16% respectively. A higher frequency was noted for the highly attached upper labial frenum and thick upper lip (46.9%, and 44.9% respectively). No significant differences were noted in the frequency of these oral manifestations between the different Sillence types of OI.

V- shaped palate were detected only in one case, also mandibular micrognathia, dislocation of TMJ, upper pseudo labial cleft, fissured tongue, and delayed eruption were not detected in any of the studied OI cases. Jensen and Lund (1997) reported that the more severe abnormalities of craniofacial features were associated with OI in adult patients.

Early eruption of the teeth in OI type I cases of this study was present in 7.7% but was not present in other types. Delayed eruption of teeth was not noted in any of the studied patients. Some studies showed that ectopic eruption of first and second molars has been found to be more common in OI cases (Schwartz and Tsipouras 1984, Stenvik *et al*. 1985, and O'Connell and Marini 1999).

O'Connell and Marini (1999) investigated 40 OI cases, and showed that 6 patients experienced impaction of their second permanent molars, which caused a significant delay in eruption of these teeth and reported that no other impactions were noted.

The percentage of DI in the studied OI cases ranged from 7.7% for type I, 26.9% for type III, and 22.2% for type IV, these were in agreement with *Saeves et al.* (2009) who mentioned that the clinical DI with discolouration of teeth occurred in 19% of the participants. Higher percentage rates of DI, ranging between 28 % to 73%, were reported in other studies (Schwartz and Tsipouras 1984, Lukinmaa *et al*. 1987, Lund *et al.* 1998, Malmgren and Norgren 2002).

O'Connel and Marini (1999) reported that DI was present in the primary dentition in more than 80% of patients with OI types III and IV, which was significantly greater than the 50% previously reported for most OI populations. These were in disagreement with Sanches *et al*. (2005) who found DI in 8 to 40% in patients with type I OI, in 43 to 82% in type III OI and in 37 to 100% in type IV.

DI when present in OI, represents an abnormality of the dentin but, as with blue sclerae, it may be difficult to quantitate with the degree of severity of OI. Only those teeth which are short, discolored (usually brownish), and opalescent are considered characteristic (Falvo 1974).

Enamel hypoplasia of OI cases in this study was 7.7% for type I, 23% for type III, and 11.1% for type IV. However the percentage of enamel hypo-calcification was 30.8% for type I, 30.7% for type III, and 11.1% for type IV. In a study carried out on Egyptian OI patients, Elhossini (2009) showed that DI was detected in 6 cases with type III and 1 case with type IV but enamel hypocalcification was present in 3 cases with type I, 3 cases with type III and 1 case with type IV. Enamel hypoplasia was noted in 1 case of each type. Enamel hypocalcification and enamel hypoplasia may represent a milder affection of teeth in OI. The author reported

that the low percentage of DI in their studied patients shows that it cannot be considered a major criterion in any type of OI.

On the other hand, attrition of the teeth was only present in 7.7 % of OI type III patients which seems to be associated with DI and enamel hypoplasia.

In this study we met difficulty to distinguish between the Sillence different types of OI on the basis of clinical dental features (DI, enamel hypoplasia, and enamel hypocalcifications), nor did these features correspond to the severity of bony involvement. Sillence (1988) mentioned that each type of OI is further subdivided on the basis of the absence or presence of DI.

The presence of yellow/brown discoloration with enamel fractures in the primary dentition suggested that early restorative intervention should be provided. Opalescent gray discoloration suggested a more favorable prognosis. Malmgren and Norgren (2002) stated that DI specific oral manifestation is commonly observed in patients with OI and the evidence of disturbances in dental development can be crucial for establishing the OI diagnosis.

Others reported that although the enamel of teeth affected by DI has normal structure and normal or infrequently decreased mineral content, it tends to crack away from tooth surface, thereby exposing the softer dentin that undergoes rapid and severe attrition, Enamel dislodgement may be attributed to the fact that the dentino enamel junction (DEJ) in teeth of patients with OI is smooth. Nevertheless, sometimes, the DEJ appears with normal scalloping and the disruption is assumed to occur in a low mineralization dentin zone (Lindau *et al.* 1999, O' Connel and Marini 1999, and Mahoney *et al.* 2001).

The occurrence of posterior cross bite in the studied OI cases ranged from 0% for type I and type III, and 11.1% for type IV, these were in accordance with Helm *et al.* (1983) while in disagreement with O' Connel and Marini *(*1999*)* and Gupte *et al.* (2006) who showed high incidence of anterior and posterior cross bite in OI cases, also these were in disagreement with Schwartz and Tsipouras (1984) who reported that the percentage of cross bite in OI cases was 65%.

Missing teeth in OI cases in the present study were only present in 11.1% of OI type IV, in disagreement with Schuller and Holst (1998), and Kirkevang *et al.* (2001) who mentioned that persons with OI have more missing and endodontically treated teeth compared with the general population. However O'Connell and Marini (1999) showed that the missing teeth were noted in 10% of their patients (n = 4); each of 2 patients with type III OI was missing one upper second premolar; 1 patient with type IV OI was missing the lower left lateral incisor. The remaining patient with type III OI was congenitally missing all 4 second premolars and 3 second molars.

Open bite in the studied OI patients was present only in 7.7% of OI type I, and in 30.7% of OI type III. However the percentage of deep over bite ranged from 23% for type I, 3.8% for type III, and 0% for type IV. These were in disagreement with O' Connel and Marini (1999) who found a high incidence of both anterior and posterior open bites, and reported that the presence of an anterior open bite was related to prolonged use of a pacifier in only 1 person; the remaining cases reflected the class III tendency. Posterior open bites were present in 27% of the patients with type III OI and 33% of the patients with type IV OI. Posterior open bites occurred with advancing age and were often bilateral; their incidence was 46% in patients greater than 9 years of age for both groups.

Edge to edge malocclusion was only present in 22.2% of the studied OI type IV. Class II dental malocclusion wasn't recorded among the examined OI patients, this was in disagreement with O' Connel and Marini (1999) who found the incidence of Class II malocclusion 9.1% in OI type III and 15.9% in OI type IV.

However, the prevalence of class III malocclusion was only present in 7.7% of OI type III. This was lower than that recorded by Schwartz and Tsipouras (1984) and Gupte *et al.* (2006) who showed 75% class III malocclusion in OI cases, O' Connel and Marini (1999) reported that the class III dental malocclusion occurred in 70 to 80% of types III and IV of OI population.

The results of this study revealed that some patients with OI display no clinical or radiographic abnormalities in the dentition, whereas others manifest significant dentinal involvement. It also showed that it was difficult to distinguish between the Sillence different types of OI on the basis of oral-dental manifestations, this was in agreements with O' Connel and Marini *(*1999*)*.

Specific mutations in the collagen 1 genes in OI patients studied by Ranta *et al. (*1993*)* and Luder and Steinman (1996) did not demonstrate a clear relationship between the genetic defect and the oral or dental manifestations of OI. However, as more mutations in persons with OI are described, the correlation of the clinical and molecular data may be better understood.

The racial factor might be the cause that explains why the results of this study were different from the results of the other literatures (Isshiki 1966, Schwartz and Tsipouras 1984, Stenvik *et al.* 1985, Lukinmaa *et al.* 1987, Sillence 1988, Jensen and Lund 1997, Lund *et al.* 1998, Schuller and Holst 1998, O'Connell and Marini 1999, Kirkevang *et al.* 2001, Malmgren *et al.* 2002, Sanches *et al.* 2005, and Gupte *et al.* 2006). However it is important to emphasize that early orodental examination and regular follow up of patients with OI is highly recommended.

***Conclusion:***

From the results of this study; it could be concluded that: It is difficult to differentiate between the Sillence different types of osteogenesis imperfecta based on the clinical or radiographic features of oro-dental manifestations.

***Recommendation:***

Early orodental examination and regular follow up of patients with OI is highly recommended for maintaining the oral and dental health of those patients as possible as we can.

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