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Oral Health in Individuals with Down Syndrome

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1. Introduction

John Langdon Down (1866) first described the clinical entity of Down Syndrome (DS) at mid-nineteenth century and one century later, the DS primary cause due to trisomy 21 was reported (Lejeune et al., 1959). Until now, the etiology of Down syndrome remains unknown. DS is predominantly due to non-disjunction of chromosome 21; while translocation of an extra copy of the same chromosome accounted for a small proportion of the condition. A mosaic vary of the situation comes about when the extra chromosome 21 is present in some, but not all, cells of the affect individual.

DS itself is not a disease, however affected individuals have greater risk in acquiring many systemic conditions. Persons with DS are susceptible to upper respiratory tract and chest infections. Approximately 50% have some forms of heart defect, usually ventricular septal defect, some may require antibiotic cover for invasive dental treatment. Alzheimer disease is a problem in later life of DS individuals.

Down syndrome is characterized by central growth deficiency with delayed mental and physical development. All individuals with DS are mentally impaired to some degree, ranging from mild to severe.

There is a unique combination of facial features in DS subjects, regardless of race or ethnicity. Persons with DS are often short with a short neck and underdeveloped or hypoplastic mid-face, with outer canthus of the eye higher than the inner giving rise to slant-eyes appearance. The palpebral fissure is narrow, and there is often a medial epicanthic fold. There may be speckling of the iris (Brushfield's spots), cataracts, eye infections and bi- or uni-lateral strabismus. The mid-face hypoplasia often associates with poorly developed paranasal air sinuses, giving rise to a sloping forehead and a flat face. Class III malocclusion and relatively prognathic mandible are also common observations.

DS is the commonest chromosomal abnormality in live-born infants (Bower et al., 2000). DS has been estimated to occur in approximately 1 in 732 infants in the United States (Sherman et al., 2007). In the United Kingdom, the overall prevalence of DS is 1.08 per 1000 live births from 1985-2004 and one-year survival of live births with DS increased, especially in babies with cardiovascular malformations, reaching almost 100% (Irving et al., 2008). Long-term survival is also improving, and the large majority of people with DS are now expected to live well into adult life, due to better living conditions, better health care and more sophisticated surgical techniques (Glasson et al. 2002). Health care workers, educationists and whoever involved are therefore required to keep up with the current knowledge and development of contemporary DS management strategies.

2. Oral features of Down syndrome individuals

2.1 Soft tissues

Common oral soft tissue manifestations of DS individuals include large and fissured tongue, cracked lips (Figure 1). The tongue in DS is large (macroglossia) relative to the size of the oral cavity. In fact, studies have shown that the tongue size of individuals with DS does not differ significantly from that of the general population (Ardran et al., 1972). It is the oral space, which is small (Guimaraes et al., 2008). There can be marked fissuring of the dorsum of the tongue, and because of poor muscular control, the tongue is often protruded.



Fig. 1. Common oral soft tissue feature of Down Syndrome individuals. A. cracked lip; B. Large tongue relative to size of oral cavity. Subject also has microdontia or peg-shaped upper lateral incisors.

Generalized orofacial muscles hypotonia e.g. orbicularis, zygomatic, masseter, and temporalis muscles, contributes to poor oral seal, poor suck, poor tongue control, and difficulties with jaw stability. The angle of the mouth is pulled down with elevated upper lip. The lower lip is thick, dry, fissured and everted (Desai, 1997). Persistent mouth opening due to the relatively large tongue in a reduced oral cavity may lead to mouth breathing, drooling, chapped lower lip, and angular cheilitis or infectious lesion at the corner of the mouth. The mucosal lining of the oral cavity is thin because of the reduction in salivary flow rate (Siqueira Jr. & Nicolau, 2002). Chaushu et al. (2002) also argued that drooling in DS individual was due to open mouth posture, protruded tongue and hypotonic orofacial muscle instead of hypersalivation, since they demonstrated a reduced stimulated parotid salivary flow rate.

Tongue appears with bilateral, unilateral or isolated oval depression and is described as raised white scalloped border. This usually is caused by frictional movement against teeth, diastema, tongue thrusting, tongue sucking, clenching or enlarged tongue (Langlais et al., 2009). Geographic and fissured tongue is also seen in DS individuals (Laskaris, 2003). Fissured or scrotal tongue consists of various patterns, lengths and depths: single midline fissure, double fissures, or multiple fissures of the dorsal surface of the anterior two thirds of the tongue (Langlais et al., 2009). This condition is asymptomatic, however it may cause food impaction and subsequently halitosis. Increases in bifid uvula, submucous cleft and cleft palates have been reported in this population (Crespi, 1993).

2.2 Midfacial complex and palate

The development of whole craniofacial complex is retarded and the facial profile is relatively concave. The maxilla in DS individual is deficient in development and the mandible is of normal size or slightly hypoplastic (Boyd et al., 2004). The deficient

development in vertical height of the maxilla resulted in overclosure of the mandible and thus projected the lower arch forward relative to upper (Desai, 1997).

DS patients displayed significantly higher frequency of shelf-like or "stair palate" (Skrinjaric et al., 2004). Westerman et al. (1975) compared 40 DS individuals with 44 control subjects and concluded that the palatal dimension were narrower in width, shorter in depth, and lower in height. In fact, the terms high arch and narrow palatal vault (Figure 2) were subjectively described and only partly correct.



Fig. 2. Deficient maxillary development in Down Syndrome individual leading to narrow palatal vault.

2.3 Malocclusion

Malocclusion or improper meeting of the upper and lower teeth is common in DS individuals and there is a large deviation in occlusal relationship (Lowe 1990). The following factors play an important role in malocclusion: mouth breathing, improper chewing, evidence of bruxism, tooth agenesis, midline deviation in upper arch, anterior open bite, spacing of teeth, dysfunction of temporomandibular joint, delayed eruption and/or exfoliation of both deciduous and permanent dentition, characteristic tongue thrust, hypotonic ligamentary apparatus of temporomandibular joint, developmental disturbances of the mandible (platybasia) and maxilla (midfacial complex), and the jaw relationships (Borea et al., 1990).

2.3.1 Malalignment

Ondarza et al. (1995) analyzed 136 individuals with DS and compared them with mentally impaired individuals and normal Chilean individuals. They showed a higher frequency of malalignments in both the primary and permanent dentition compared with the other groups. The most frequently involved teeth were central incisors, lateral incisors and canines. Anterior and posterior crowding was also often seen in DS individuals (Reuland-Bosma & van Dijk, 1986). Crowding is frequent, especially in maxilla, due to underdevelopment (Figure 3A & B).

Increased in prevalence of canine impaction (15%), and upper canine and first premolar transposition (15%) were also found in DS individuals (Figure 3C & D), which was a phenomenon that could only be explained by genetic anomaly (Shapira et al., 2000).

2.3.2 Jaw relationships

Angle Class III malocclusion was present in two thirds of DS individuals (Boyd et al., 2004).

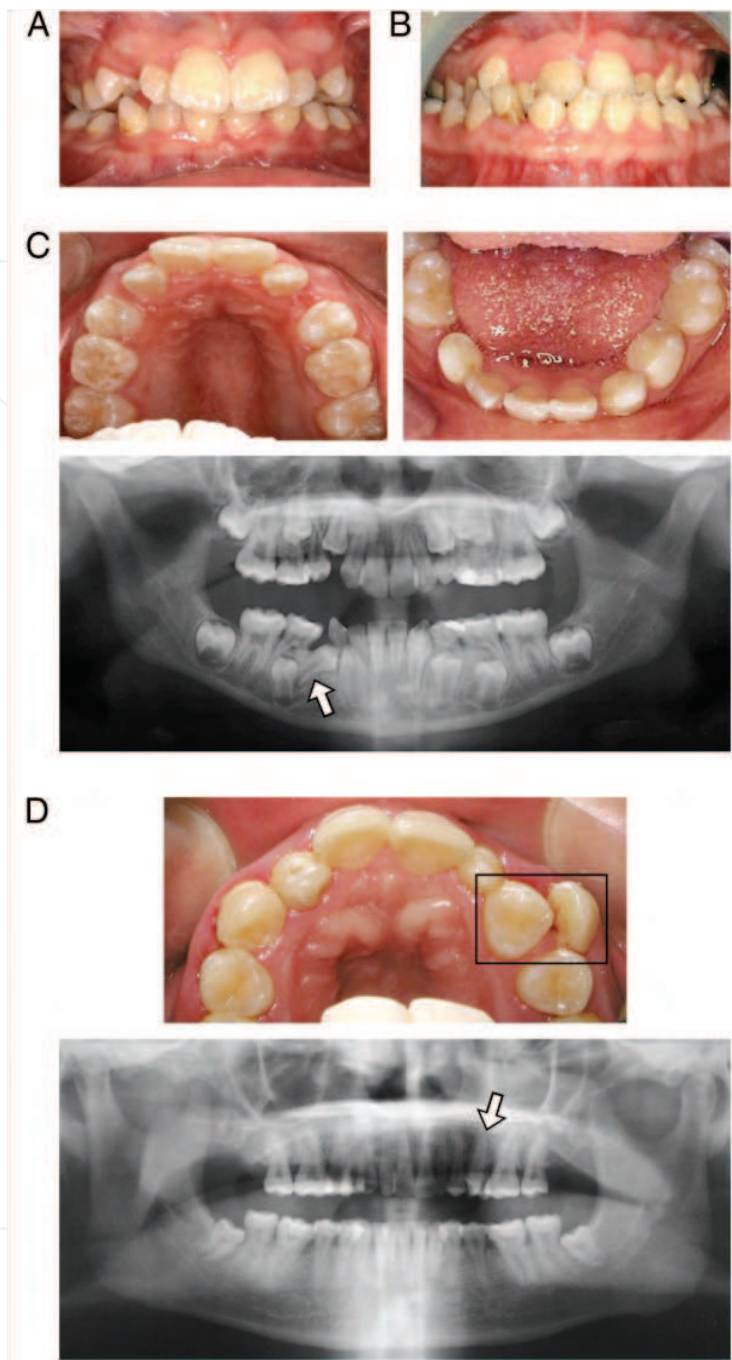


Fig. 3. Malalignment and tooth impaction in Down Syndrome subjects. A. Malaligned mixed dentition; B. Malaligned permanent dentition; C. Impacted lower right first premolar (arrow). Subject also has missing lower left lateral incisor; D. Transpositioned upper left canine and first premolar (box and arrow).

The higher incidence of Class III malocclusion is due to underdevelopment of the midface and not to prognathism. Approximately 69% of them had mandibular overjet. Other findings were anterior open bite, posterior crossbite, anterior crossbite, mesial molar occlusion, sagittal malocclusion (Desai, 1997) (Figure 4). Vigild (1985) recorded in 37 DS cases with 41% mandibular overjet, 54% mesial molar occlusion, 38% open bite and 65% crossbite.



Fig. 4. Common jaw relationships of Down Syndrome subjects. A. Angle Class III malocclusion with posterior cross bite. Also note subject has enamel hypoplasia; B. Angle Class III malocclusion with anterior open bite.

2.4 Hard tissues

Dental features associated with DS individuals include: microdontia of permanent dentition, altered crown morphology and shape, short root, enamel hypoplasia and hypocalcification, thinner enamel and dentine in the permanent dentition, taurodontism, hypodontia and supernumerary teeth, asymmetry and delayed eruption (Desai, 1997) (Figures 1B, 3C, 4A, 5A & 5B).

2.4.1 Microdontia

DS individuals presented with true generalized microdontia in permanent dentition (Lowe, 1990), but in primary dentition, this is less well documented (Bell et al., 2001, Kieser et al., 2003). Clinical crowns are frequently conical, short, and small (Townsend 1983, 1987).

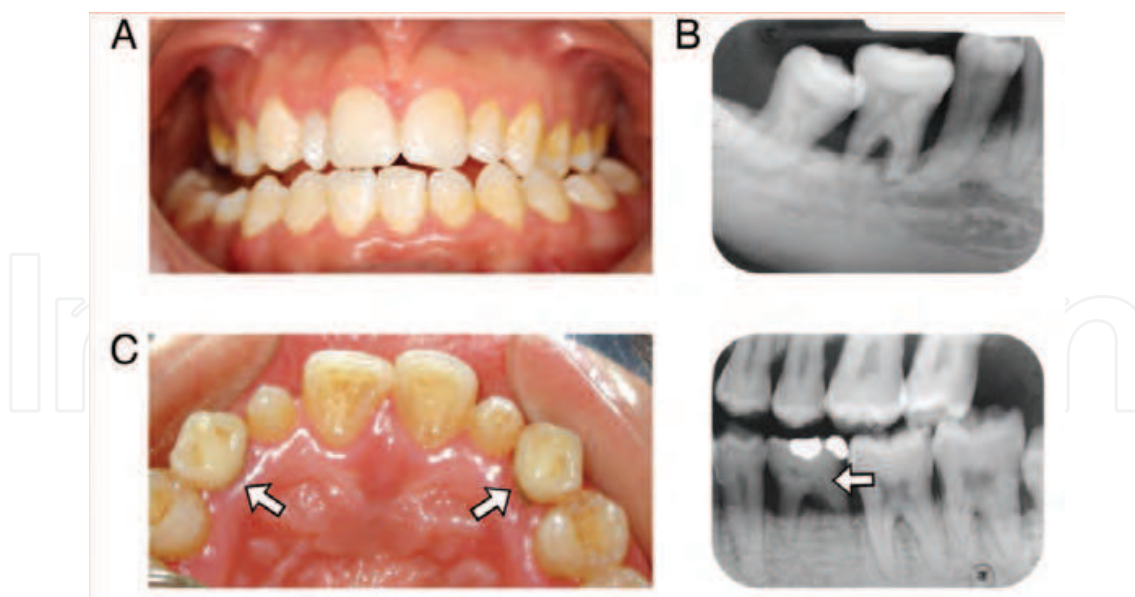


Fig. 5. Dental hard tissue anomalies of Down Syndrome subjects. A. Microdontia or peg-shaped right lateral incisor; B. Short rooted lower right molars. Also note subject has radiographic sign of bone loss around teeth indicating periodontitis; C. Retained primary or deciduous upper canines (arrows) or lower left second primary molar (radiograph, arrow). Please note the corresponding permanent successors in both cases are missing.

Bell et al. (2001) examined the lower incisors dimension of individuals with DS and found that reduced permanent crown size was associated with a reduction in both enamel and dentine thickness and enamel was actually significantly more reduced. Desai (1997) reported that all teeth except the upper first molars and lower incisors were reduced in size, with complete root formation. Peg-shaped lateral incisors (Cheng et al., 2007), shovel incisors and slender canines were frequently seen (Scully, 1976).

2.4.2 Hypodontia

Dental agenesis is a common characteristic in DS individuals, ranges from 30-53%, and the teeth most frequently absent in them are also most often absent in normal population (Kieser et al., 2003).

Both Japanese (Kumasaka et al., 1997) and Brazilian studies (Acerbi et al., 2001), found 60-63% of DS individuals had one or more missing teeth. In a detailed study, Russell and Kjaer (1995) studied 100 DS individuals and compared with Danish normal population. Missing teeth had a 10 times greater frequency in DS individuals than in general population and a higher frequency in males than in females. Agenesis occurred more frequently in the mandible than in the maxilla and most often on the left side. The most frequent absent teeth were lower incisors, followed by upper second premolars, upper lateral incisors, lower second premolars, upper second molars, lower central incisors and canines. As from an earlier U.S. study (Orner, 1971), the author reported that 53% out of 212 DS individuals had missing permanent teeth. The descending frequency of missing teeth were the upper lateral incisors (31%) followed by the lower second premolars (26%), upper second premolars (18%), lower lateral incisors (12%), and lower central incisors (7%).

Due to missing permanent successor, the corresponding primary tooth did not resorb or resorbed so slowly that it could be retained well into adulthood (Figure 5C).

2.4.3 Abnormal crown and root morphology

Enamel hypoplasia and hypocalcification, affecting both primary and permanent dentitions, are relatively common in DS children (Figure 4A). Severity of tooth wear was significantly greater in DS children when compared to unaffected children, with DS children displaying a multifactorial aetiology of tooth wear, including attrition and erosion (Bell et al., 2002). Except for mandibular first premolar, crown and root lengths of permanent teeth are shorter than normal (Kelsen et al., 1999). Taurodontism is frequent finding in persons with DS (Rajić & Mestrović, 1998). Taurodontism together with abnormally short root would reduce extent of periodontal attachment and result in tooth mobility commonly seen in these persons (Figure 5B).

2.4.4 Eruption of primary dentition

Primary dentition in DS individuals usually developed late and subsequently delayed the eruption, particularly upper and lower anterior teeth and first molars. Ondarza et al. (1997) compared 255 Chilean DS individuals against normal population and showed that central incisors, lateral incisors and canines' eruption were delayed significantly. However, they reported the chronologic age of primary tooth eruption within DS individuals was not significantly different.

As usual, central incisors erupted first, and second molars usually last, but in between there was a great deal of variation in the sequence of eruption. The first eruption was usually at the age of 12 to 14 months but could be delayed up to 24 months and taking up to 4 to 5 years of age to complete (Desai, 1997).

2.4.5 Eruption of the permanent dentition

Eruption of permanent dentition is also delayed in DS individuals. 240 Chilean DS individuals were studied (Jara et al., 1993). They had altered eruption sequence but the authors argued that this was not necessarily a consequence of alterations in the time of eruption. Six year old molars and lower incisors could erupt until the age of 8 to 9 years (Desai 1997).

A New Zealand nationwide survey on DS individuals' oral condition was carried out by Cutress (1971a & 1971b). The author found that the chronologic sequence of eruption in DS individuals was similar to the normal population. The least affected teeth were upper and lower first molars and central and lateral incisors. Asymmetries between left and right side mainly affected the canines and premolars. Children with DS maintained a certain similarity in eruption sequence and symmetry compared with normal children.

3. Oral diseases of Down syndrome individuals

3.1 Dental caries

Low prevalence of dental caries or tooth decay in both primary and permanent dentitions of DS individuals has been widely reported (Cutress, 1971a; Orner, 1975; Barnett et al., 1986; Vigild, 1986; Ulseth et al., 1991; Gabre et al., 2001; Bradley & McAlister, 2004; Cheng et al., 2007; Dellavia et al., 2009; Davidovich et al., 2010). Cutress (1971a) examined 416 DS subjects and found lower prevalence of dental caries than normal population, but after adjusting the age of teeth eruption, there were only small and no significant difference between 2 groups. Later in another study (Orner, 1975), when dental caries experience was compared between DS individuals and their siblings, it was found that DS individuals experienced less than one third caries than their unaffected siblings. Similarly, a study by Barnett et al. (1986) in

New Jersey, USA, reported that DS individuals had lower caries prevalence when compared with age matched mentally disabled subjects.

Vigild (1986) reported that DS individuals had less carious lesions but also fewer permanent teeth than those mentally retarded individuals. However, when data was analyzed on the basis of tooth numbers and not on tooth surfaces, the author concluded that individuals with DS were also susceptible to caries.

Ulseth et al. (1991) had also found that while the caries prevalence of adults with DS was lower than Norwegian general population, it was similar to that of people with other disabilities. Comparing with subjects of similar mental status, Bradley and McAlister (2004) reported that among the 71 Irish children with DS, higher prevalence of caries free children was observed than children in special needs or mainstream schools. DS individuals who were caries free had significantly lower *Streptococcus mutans* counts (Shapira et al., 1991) and elevated salivary *Streptococcus mutans* specific IgA concentrations (Lee et al., 2004).

The low caries prevalence had been postulated to be related to delayed eruption, reduced time of exposure to a cariogenic environment, congenitally missing teeth, higher salivary pH and bicarbonate levels, microdontia, spaced dentition, and shallow fissures of the teeth (Desai, 1997; Boyd et al., 2004). Recently, it has been shown that a different salivary environment of electrolytes and pH is manifested in DS children, leading to the lower reported caries rate (Davidovich et al., 2010)

3.2 Periodontal disease

DS individuals usually present with poor oral hygiene and manifested as marginal gingival inflammation, acute and subacute necrotizing gingivitis, advanced chronic periodontitis, loss of attachment in form of gingival recession and increased pocket depth, alveolar bone loss, suppuration or even abscesses, furcation involvement in the molars, increased tooth mobility, and even loss of teeth (Shaw & Saxby, 1986) (Figures 5B & 6).

DS individuals had a prevalence of 60 to 90% percent and increased severity of periodontal disease compared with normal age-matched controls and subjects with other mental disabilities of similar age (Cutress, 1971b; Orner, 1976; Barnett et al., 1986; Reuland-Bosma & van Dijk, 1986; Modeer et al., 1990; Shapira et al., 1991; Ulseth et al., 1991; Desai, 1997; Gabre et al., 2001; Lopez-Perez et al., 2002; Sakellari et al., 2005; Cheng et al., 2007; Khocht et al., 2010). Obviously the severity of periodontal disease among DS individuals is milder in recent years' reports as better dental care have been employed to take care of them early in their life.

Lopez-Perez et al. (2002) examined 32 DS individuals and age-matched controls and found that there were greater extent of gingivitis and periodontitis in DS group. When comparing with subjects affected by other learning disabilities of similar age distribution, DS individuals exhibited earlier, rapid and generalized periodontal destruction (Saxen et al., 1977; Barnett et al., 1986). In Finland, Saxen et al. (1977) compared panoramic radiographs of DS individuals versus age-matched control and reported that 84% of DS adults showed advanced bone loss of 2.5mm or more as compared with only 27% in the controls. Barnett et al. (1986) examined 30 DS individuals and 30 similar mental status individuals and reported that bone loss was found in 60% of sites of DS individuals versus 9.3% of sites in controls.

Sakellari et al. (2005) investigated the severity of periodontal disease in DS individuals and compared the group with healthy individuals or cerebral palsy patients. They reported that periodontal inflammation and treatment needs were significantly higher in DS individuals. Shaw and Saxby (1986) showed that DS individuals had periodontal bone loss pattern

similar to that of juvenile periodontitis. Lower incisors were reported exhibiting early signs of alveolar bone loss in approximately 35% of DS adolescents (Modeer et al., 1990; Barr-Agholme et al., 1992).

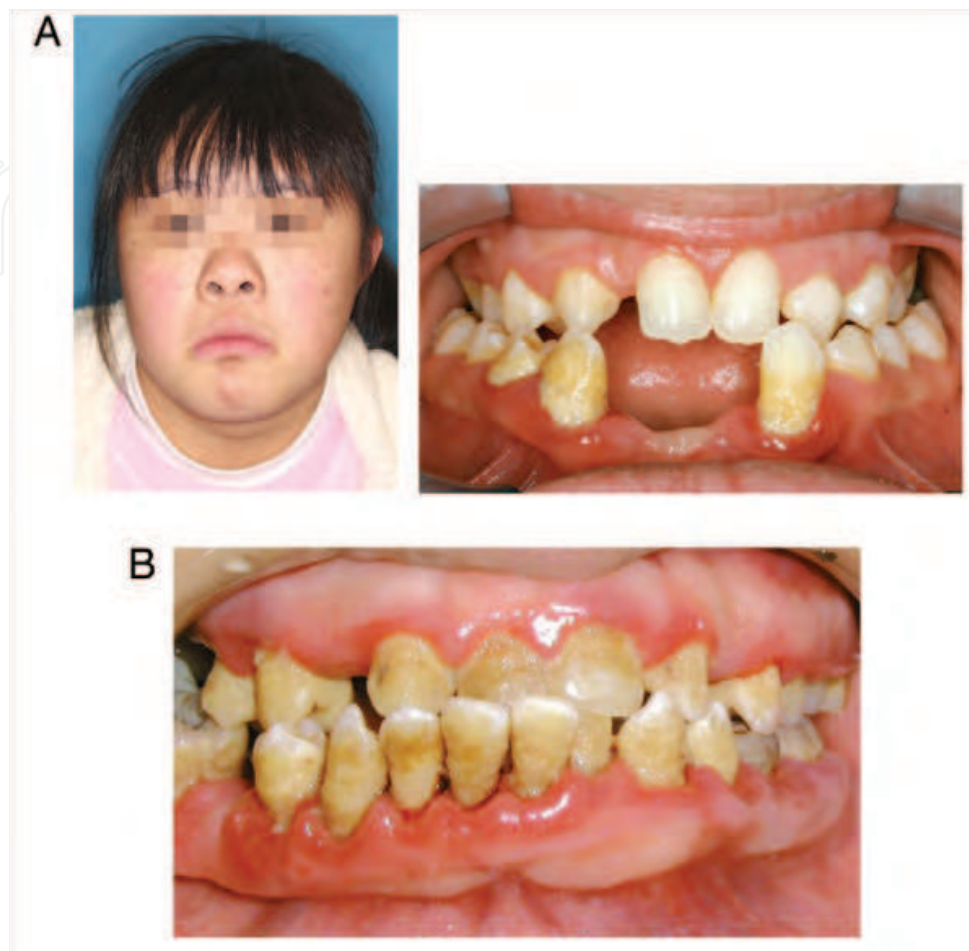


Fig. 6. Periodontal disease in Down Syndrome subject. A. Gingival inflammation in lower dental arch, mixed dentition. Subject also has congenital missing upper lateral incisors and all lower incisors; B. Periodontitis in permanent dentition of an adult DS individual.

There is only one longitudinal study to record the development of periodontal disease in DS adults. After 7 years observation, Agholme et al. (1999) found the prevalence of bone loss increased from 35% to 74% among 33 DS individuals. The severity and progression of the disease, however, was not as rapid as reported in the literature.

Bradley and McAlister (2004) suggested that majority of DS children had poor oral hygiene, but they could not demonstrate the children had earlier onset periodontal disease. At the same time, there was only moderate relationship between dental plaque and periodontal disease severity in DS individuals (Lopez-Perez et al., 2002). Thus, rapid and severe periodontal destruction in those DS individual affected could not be explained by poor oral hygiene alone (Reuland-Bosma & van Dijk, 1986).

4. Management principles for oral diseases in Down syndrome individuals

There are quite a number of distinguished developmental or behavioral features and systemic manifestations associated with DS individuals which could affect oral diseases

management. The followings are brief summary regarding how aspects of such features can affect oral health.

4.1 Development, behavior, mental status, cognitive and early aging

Persons with DS certainly have learning disability. Despite the homogeneity of low IQ and delayed mental development, DS individuals have different characters. DS children develop to a plateau in their adolescence which attain overall learning abilities equivalent to unaffected children aged 6 to 8 years. Knowing that oral hygiene of 6-year-old are not as good as 8-12 year-old children (Sandström et al., 2011), the anticipated oral hygiene of DS subjects would not be ideal if no special extra attention is given. Moderate to mild mental retarded individuals are on the other hand, mobile, function and perform well and highly motivated in sheltered workshop (Crespi, 1993). Common characteristics observed in young DS individuals have been described as quiet, passive, natural spontaneity, genuine warmth, penetrating calamity in relating to other people, fond of music, gentleness, patience and tolerance, complete honesty (Desai, 1997). All these together make supervised group oral hygiene approach possible (Shyama et al., 2003). Approximately 30% of the individuals with DS are affected by dementia (Kieser et al., 2003) when they get older. Although the degree of intellectual disability affects the efficacy of supragingival or above the gum line plaque control, sustaining individuals with DS motivation by supervised toothbrushing and systematic oral health care education could achieve good oral hygiene levels (Shyama et al., 2003).

4.2 Systemic anomalies

Medical problems associated with DS have been well noted. In Hong Kong, high prevalence of medical problems was detected in children and teenagers with DS. Among 407 DS individuals, cardiovascular problems were observed in 53%, endocrine problems in 27%, gastrointestinal problems in 11%, haematological problems in 4%, neurological problems in 7%, sleep problems in 9%, skeletal problems in 14%, visual problems in 48% and auditory problems in 34% (Yam et al. 2008). Children with DS have a 10- to 20-fold higher risk of developing leukemia (Lange, 2000). Dental treatment plans for DS subjects therefore need to be formulated upon careful and thorough medical history and appropriate precautionary measures incorporated.

4.3 Cardiac anomalies

Many DS individuals have multiple congenital cardiac defects. The most common are atrioventricular septal defects, following ventricular septal defects, atrial septal defect, patent ductus arteriosus and tetralogy of Fallot (Freeman et al. 1998). There is also an increased incidence of mitral valve disorders which include mitral valve prolapse, mitral insufficiency, deformed mitral valve, and mitral valve absence (van Dyke et al., 1990). The need of antibiotic prophylaxis should be assessed and followed. Severe form of such cardiac complications may associate with increased risk in infection of the myocardium or increased general anesthesia complications. All these can potentially hinder oral health providers in smoothly deliver primary oral health care.

4.4 Atlantoaxial instability

Approximately 13% of DS individuals (Cohen, 1998) have excess movement of the joint between C1 and C2. The presence of 5mm or more space between the posterior aspect of

anterior arch of the atlas and the odontoid process is considered atlantoaxial instability and is at a higher risk of spine translocation. Neck of DS individuals during dental treatment should be maintained in a relaxed position in order to avoid that from occurring.

4.5 Nervous system anomalies

DS boys develop gross motor skills better than fine motor skills (Hoffman et al., 1990). Although development of motor function is usually delayed and has restricted coordination, coordination improves with age (Desai, 1997). Daily dental care or plaque control may be a difficult task for DS subjects which predisposing them to periodontal disease.

4.6 Obstructive sleep apnea

Obstructive sleep apnea (OSA) is common and occurs in 50% of children with DS (Mitchell et al., 2003; Shott et al., 2006). Patients with DS have many predisposing factors for OSA, including glossoptosis, hypopharyngeal collapse, recurrent and enlarged adenoid tonsils, enlarged lingual tonsils and relative macroglossia (Donnelly et al., 2004). Dentist plays an important role in recognizing and treatment of sleep-disordered breathing. If left untreated, OSA can further developmental delay, lead to pulmonary hypotension and congestive heart failure. The most effective oral appliances for patients with DS are mandibular advancement devices that fit both the maxillary and mandibular teeth, similar to an orthodontic retainer or athletic mouthguard (Waldman et al., 2009).

4.7 Orofacial dysfunction

Orofacial dysfunction in children with DS is related to mouth breathing, muscle hypotonia and discrepancy between alveolar arches (Faulks et al., 2008a). Early appliance therapy using Castillo-Morales plate had been promising in stimulating the lips and tongue and improving oromotor function (Carlstedt et al., 2003, Backm  n et al., 2007). A long-term follow up study of children with DS, being treated with Castillo-Morales plate at a mean age of 13 months for 19 months, showed improved orofacial appearance and function that remain stable after 13 years (Korbmacher et al., 2006). Oromotor therapy may also be combined with functional orthodontic treatment such as palatal expansion with removable appliance, elimination of occlusal interference by grinding and use of composite overlay to free mandibular movement in older DS children (Faulks et al., 2008b).

4.8 Dental diseases

Down syndrome is characterized by abnormalities in learning, memory, and language that lead to mild-to-profound impairment in intellectual functioning. Vision hearing disorders and hypothyroidism can further negatively impact cognitive functioning in children with DS (Lott & Dierssen, 2010). There is often a delay or impairment in language development in DS children. Receptive language is typically stronger than expressive language, and vocabulary is stronger than syntax (Martin et al., 2009). They exhibit phonological-altered spoken communication with more unimodal gestural answer. Dentist should find out from caregiver the patient's level of intellectual and functional abilities and communicate directly with DS individuals using short, clear instructions. The primary caregiver is encouraged to stay with DS individuals during dental treatment to enhance cooperation and communication. Visuo-spatial processing and perception are generally viewed as relative strengths in individuals with DS, therefore preventive advice should be given together with pictures, diagrams and models.

4.8.1 Caries

Various studies have shown a reduced prevalence of caries in DS children when compared with unaffected children (Stabholz et al., 1991; Bradley & McAlister, 2004; Cogulu et al., 2006; Davidovich et al., 2010). It has been reported that young DS children had prolonged use of bottle as a result of feeding problems or behavioral difficulties, with increased risk of developing nursing bottle caries (Randell et al., 1992) (Figure 7). Paired analysis of Candaian DS and non-DS siblings showed that children with DS were less likely to receive caries-preventive treatment, restorative care and more likely to have had a dental extraction (Allison & Lawrence, 2004; Fung et al., 2008). This highlights the importance of early preventive care in children with DS.



Fig. 7. Dental decay (caries) in Down Syndrome subject. Nursing bottle caries in early mixed dentition. Almost all primary teeth are involved.

The first dental visit of DS children should occur at the 12-18 months of age to monitor tooth development and eruptions. An intensive preventive programme is recommended and should include: regular oral hygiene motivation, dietary counseling, topical fluoride and fissure sealants application. Motor development is usually delayed in younger DS children and may lead to reduced manual dexterity of the children. Parents and caregivers should be educated on the need to help with tooth brushing until the individual has acquired sufficient motor skills (Desai, 1997).

Most DS children are affectionate and cooperative for dental treatment; while some may require treatment under sedation or general anaesthesia. Children with DS exhibit atlantoaxial instability, extreme care is needed during intubation and orientation of head by the paediatric dentist during provision of dental treatment under general anaesthesia.

4.8.2 Periodontitis

Periodontal treatment needs were obviously higher in DS adults than in normal healthy adults (Shapira et al., 1991; Sakellari et al., 2005). Cichon et al. (1998) reported that there was no improvement in clinical and microbiological parameters after a single session of scaling and root planing and oral hygiene instructions. The conventional standard periodontal therapy could not eliminate periodontal pathogens or even had no remarkably effect on subgingival microbiota. The authors attributed these unsatisfactory clinical outcomes to poor plaque control and impaired host defense mechanisms.

However, Sakellari et al. (2001) suggested that a frequent recall program with 3-month period could overcome inadequate supragingival plaque control and subsequently altered subgingival environment after treating five DS individuals with non-surgical periodontal therapy for 6 months. Yoshihara et al. (2005) also advocated providing periodic preventive care to DS individuals in order to suppress the progression of periodontal disease. The authors compared individuals who had frequent dental visit (mean intervals between visits: 3.7 ± 1.3 months) versus those who had visits more than one year apart and revealed that the regular review group had better clinical parameters. Cheng et al. (2008) reported satisfactory healing response on 21 DS individuals treated by non-surgical mechanical periodontal therapy (followed by monthly recalls) and the adjunctive use of chlorhexidine gel for toothbrushing and chlorhexidine mouthwash twice daily.

It appears from the above conflicting and varied findings, conventional periodontal therapy which involves oral hygiene instructions, scaling and root debridement cannot guarantee good gingival healing response. The standard gingival response to debridement is gingival shrinkage. Gingival recession connotes reduction in pocket depth, elimination of excessive sulcular depth. Besides, restoration of normal contour and color of the gingiva, reduction of gingival exudates can be gradually achieved. However, there is still no gold standard available indicating how periodontal disease in DS adults can be best managed and no evidence showing vigorous periodontal treatment may prevent periodontal disease progression or prolong tooth retention.

Appropriate modification of periodontal therapy involves non-surgical periodontal therapy adjuncted with regular use of chemical plaque control agents, and frequent recall schedule in DS adults may be a way forward.

5. Conclusions

DS individuals are basically a group of patients requiring special oral health care services. They have more missing, malaligned teeth and often affected with malocclusion. They have less carious teeth, but experienced more severe and extensive periodontal diseases. Despite the fact that the latter two diseases are preventable, there are inadequate resources in many communities for DS subjects or their caretakers to upkeep their oral health. DS care providers should acquire appropriate level of oral health awareness and communities can consider improving accessibility of DS subjects to oral health care in order to assist maintenance of oral and overall health for this group of special need patients.

6. References

- Acerbi, A.G., Claudio de Freitas & Gallottini de Magalhaes MHC. (2001). Prevalence of numeric anomalies in the permanent dentition of patients with Down syndrome. *Spec Care Dentist*, Vol. 21, No. 2, pp. 75-78, ISSN 1754-4505
- Agholme, M.B., Dahllof, G. & Modeer, T. (1999). Changes of periodontal status in patients with Down syndrome during a 7-year period. *Eur J Oral Sci* Vol. 107, No. 2, pp. 82-88, ISSN 0909-8836
- Allison, P.J. & Lawrence H.P. (2004). A paired comparison of dental care in Canadians with Down syndrome and their siblings without Down syndrome. *Community Dent Oral Epidemiol*, Vol. 32, No. 2, pp. 99-106, ISSN 0301-5561

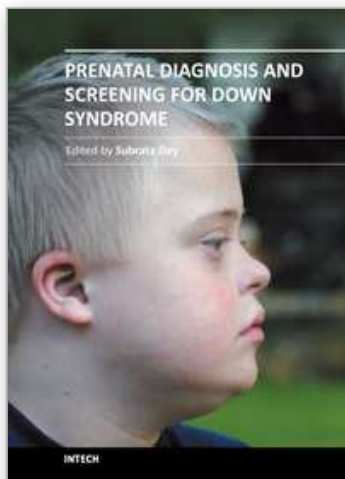
- Ardran, G.M., Harker, P. & Kemp, F.H. (1972). Tongue size in Down's syndrome. *J Ment Defic Res* Vol. 16, No. 3, pp. 160-166, ISSN 0022-264X
- Bäckman, B., Grevér-Sjölander, A.C., Bengtsson, K., Persson, J. & Johansson, I. (2007). Children with Down syndrome: oral development and morphology after use of palatal plates between 6 and 48 months of age. *Int J Paediatr Dent*, Vol. 17, No. 1, pp. 19-28, ISSN 0960-7439
- Barnett, M.L., Press, K.P., Friedman, D. & Sonnenberg, E.M. (1986). The prevalence of periodontitis and dental caries in a Down's syndrome population. *J Periodontol*, Vol. 57, No. 5, pp. 288-293, ISSN 0022-3492
- Barr-Agholme, M., Dahllof, G., Linder, L. & Modeer T. (1992). *Actinobacillus actinomycetemcomitans*, *Capnocytophaga* and *Porphyromonas gingivalis* in subgingival plaque of adolescents with Down syndrome. *Oral Microbiol Immunol*, Vol. 7, No. 4, pp. 244-248, ISSN 0902-0055
- Bell, E.J., Townsend, G.C., Wilson, D., Kieser, J.A. & Hughes, T. (2001). Effect of Down syndrome on the dimensions of dental crowns and tissues. *Am J Hum Biol*, Vol. 13, No. 5, pp. 690-698, ISSN 1042-0533
- Bell, E.J., Kaidonis, J. & Townsend, G.C. (2002). Tooth wear in children with Down syndrome. *Aust Dent J*, Vol. 47, No. 1, pp. 30-35, ISSN 0045-0421
- Borea, G., Magi, M., Mingarelli, R. & Zamboni, C. (1990). The oral cavity in Down syndrome. *J Pedodontics*, Vol. 14, No. 3, pp. 139-140, ISSN 0145-5508
- Bower, C., Leonard, H. & Petterson, B. Intellectual disability in Western Australia. (2000). *J Paediatr Child Health*, Vol. 36, No. 3, pp. 213-215, ISSN 1034-4810
- Boyd, D., Quick, A. & Murray, C. (2004). The Down syndrome patient in dental practice, part II: clinical considerations. *N Z Dent J*, Vol. 100, No. 1, pp. 4-9, ISSN 0028-8047
- Bradley, C. & McAlister, T. (2004). The oral health of children with Down Syndrome in Ireland. *Spec Care Dentist*, Vol. 24, No. 2, pp. 55-60, ISSN 1754-4505
- Carlstedt, K., Henningsson, G. & Dahllöf, G. (2003). A four-year longitudinal study of palatal plate therapy in children with Down syndrome: effects on oral motor function, articulation and communication preferences. *Acta Odontol Scand*, Vol. 61, No. 1, pp. 39-46, ISSN 0001-6357
- Chaushu, S., Becker, A., Chaushu, G. & Shapira, J. (2002). Stimulated parotid salivary flow rate in patients with Down syndrome. *Spec Care Dentist*, Vol. 22, No. 1, pp. 41-44, ISSN 1754-4505
- Cheng, R.H., Leung, W.K., Corbet, E.F. & King, N.M. (2007). Oral health status of adults with Down syndrome in Hong Kong. *Spec Care Dentist*, Vol. 27, No. 4, pp. 134-138, ISSN 1754-4505
- Cheng, R.H., Leung, W.K. & Corbet, E.F. (2008). Non-surgical periodontal therapy with adjunctive chlorhexidine use in adults with down syndrome: a prospective case series. *J Periodontol*, Vol. 79, No. 2, pp. 379-385, ISSN 0022-3492
- Cichon, P., Crawford, L. & Grimm, W.D. (1998). Early-onset periodontitis associated with Down's syndrome clinical interventional study. *Ann Periodontol*, Vol. 3, No. 1, pp. 370-380.e, ISSN 1553-0841
- Cogulu, D., Sabah, E., Kutukculer, N. & Ozkinay, F. (2006). Evaluation of the relationship between caries indices and salivary secretory IgA, salivary pH, buffering capacity and flow rate in children with Down's syndrome. *Arch Oral Biol*, Vol. 51, No. 1, pp. 23-28, ISSN 0003-9969
- Cohen, W.I. (1998). Atlantoaxial instability: what's next? *Arch Pediatr Adolesc Med*, Vol. 152, No. 2, pp. 119-122, ISSN 1072-4710

- Crespi, P.V. Metabolic and genetic jaw diseases. (1993). In: Regezi, Sciubba, editors. Oral pathology clinical pathologic correlations. 2nd edition. Philadelphia: WB Saunders Co, pp. 458-493, ISBN 0721636217.
- Cutress, T.W. (1971a). Dental caries in Trisomy 21. Arch Oral Biol, Vol. 16, No. 11, pp. 1329-1344, ISSN 0003-9969
- Cutress, T.W. (1971b). Periodontal disease and oral hygiene in trisomy 21. Arch Oral Biol, Vol. 16, No. 11, pp. 1345-1355, ISSN 0003-9969
- Davidovich, E., Aframian, D.J., Shapira, J. & Peretz, B. (2010). A comparison of the sialochemistry, oral pH, and oral health status of Down syndrome children to healthy children. Int J Paediatr Dent, Vol. 20, No. 4, pp. 235-241, ISSN 0960-7439
- Dellavia, C., Allievi, C., Pallavera, A., Rosati, R. & Sforza, C. (2009). Oral health conditions in Italian Special Olympics athletes. Spec Care Dentist, No. Vol. 29, No. 2, pp. 69-74, ISSN 1754-4505
- Desai, S.S (1997). Down syndrome: a of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, Vol. 84, No. 3. pp. 279-285, ISSN 1079-2104
- Donnelly, L.F., Shott, S.R., LaRose, C.R., Chini, B.A. & Amin, R.S. (2004). Causes of persistent obstructive sleep apnea despite previous tonsillectomy and adenoidectomy in children with down syndrome as depicted on static and dynamic cine MRI. AJR Am J Roentgenol, Vol. 183, No. 1, pp. 175-181, ISSN 0361-803X
- Down, J.L.H. (1866). Observations on an ethnic classification of idiots. London Hospital Clinical Lectures and Reports, No. 3, pp. 259-262. Reprinted in Arch Neurol. 1971, No. 25, pp. 89-90, ISSN 0003-9942.
- Faulks, D., Collado, V., Mazille, M.N., Veyrune, J.L. & Hennequin, M. (2008a). Masticatory dysfunction in persons with Down's syndrome. Part 1: aetiology and incidence. J Oral Rehabil, Vol. 35, No. 11, pp. 854-862, ISSN 0305-182X
- Faulks, D., Mazille, M.N., Collado, V., Veyrune, J.L. & Hennequin, M. (2008b), Masticatory dysfunction in persons with Down's syndrome. Part 2: management. J Oral Rehabil, Vol. 35, No. 11, pp. 863-869, ISSN 0305-182X.
- Freeman SB, Taft LF, Dooley KJ, Allran K, Sherman SL, Hassold TJ, Khoury MJ, Saker DM. (1998). Population-based study of congenital heart defects in Down syndrome. Am J Med Genet, Vol. 80, No. 3, pp. 213-217, ISSN 1096-8628
- Fung, K., Lawrence, H. & Allison, P. (2008). A paired analysis of correlates of dental restorative care in siblings with and without Down syndrome. Spec Care Dentist, Vol. 28, No. 3, pp. 85-91, ISSN 1754-4505
- Gabre, P., Martinsson, T. & Gahnberg, L.(2001). Longitudinal study of dental caries, tooth mortality and interproximal bone loss in adults with intellectual disability. Eur J Oral Sci, Vol. 109, No. 1, pp. 20-26, ISSN 0909-8836
- Glasson, E.J., Sullivan, S.G., Hussain, R., Petterson, B.A., Montgomery, P.D. & Bittles, A.H. (2002). The changing survival profile of people with Down's syndrome: implications for genetic counselling. Clin Genet, Vol. 62, No. 5, pp. 390-393, ISSN 0009-9163
- Guimaraes, C.V., Donnelly, L.F., Shott, S.R., Amin, R.S. & Kalra, M. (2008). Relative rather than absolute macroglossia in patients with Down syndrome: implications for treatment of obstructive sleep apnea. Pediatr Radiol, Vol. 38, No. 10, pp. 1062-1067, ISSN 1432-1998
- Hoffman, M.N., Peterson, L.L. & Van Dyke. D.C. Motor and hand function. (1990). In: van Dyke, D.C., Lang, D.J., Heide, F., van Duyne, S. & Soucek, M.J., editors, Clinical perspectives in the management of Down syndrome. New York: Springer-Verlag, pp. 93-101, ISBN 038796987X.

- Irving, C., Basu, A., Richmond, S., Burn, J. & Wren, C. (2008). Twenty-year trends in prevalence and survival of Down syndrome. *Eur J Hum Genet*, Vol. 16, No. 11, pp. 1336-1340, ISSN 1018-4813
- Jara, L., Ondarza, A., Blanco, R. & Valenzuela, C. (1993). The sequence of eruption of the permanent dentition in a Chilean sample with Down's syndrome. *Arch Oral Biol*, Vol. 38, No. 1, pp. 85-89, ISSN 0003-9969
- Kelsen, A.E., Love, R.M., Kieser, J.A. & Herbison, P. (1999). Root canal anatomy of anterior and premolar teeth in Down's syndrome. *Int Endod J*, Vol. 32, No. 3, pp. 211-216, ISSN 0143-2885
- Khocht, A., Janal, M. & Turner, B. (2010). Periodontal health in Down syndrome: contributions of mental disability, personal, and professional dental care. *Spec Care Dentist*, Vol. 30, No. 3, pp. 118-123, ISSN 1754-4505
- Kieser, J., Townsend, G. & Quick, A. (2003). The Down syndrome patient in dental practice, part I: pathogenesis and general and dental features. *N Z Dent J*, Vol. 99, No. 1, pp. 5-9, ISSN 0028-8047
- Korbmacher, H.M., Limbrock, J.G. & Kahl-Nieke, B. (2006). Long-term evaluation of orofacial function in children with Down syndrome after treatment with a stimulating plate according to Castillo Morales. *J Clin Pediatr Dent*, Vol. 30, No. 4, pp. 325-328, ISSN 1053-4628
- Kumasaka, S., Miyagi, A., Sakai, N., Shindo, J. & Kashima, I. (1997). Oligodontia: A radiographic comparison of subjects with Down Syndrome and normal subjects. *Spec Care Dentist*, Vol. 17, No. 4, pp. 137-141, ISSN 1754-4505
- Lange, B. (2000). The management of neoplastic disorders of haematopoiesis in children with Down's syndrome. *Br J Haematol*, Vol. 110, No. 3, pp. 512-524, ISSN 0007-1048
- Langlais, R.P., Miller, C.S. & Nield-Gehrig, J.S. (2009). *Color Atlas of Common Oral Diseases*. 4th edition. Philadelphia: Lipponcott Williams & Wilkins, ISBN 9780781780971.
- Laskaris, G. (2003). Diseases of the tongue. In: *Color atlas of oral diseases*. 3rd edition. Stuttgart; New York: Thieme, pp. 120-129, ISBN 3137170036.
- Lee, S.R., Kwon, H.K., Song, K.B. & Choi, Y.H. (2004). Dental caries and salivary immunoglobulin A in Down syndrome children. *J Paediatr Child Health*, Vol. 40, No. 9-10, pp. 530-533, ISSN 1034-4810
- Lejeune, J., Gautier, M. & Turpin, M.R. (1959). Etude des chromosomes somatiques de neuf enfants mongoliens. *C R Acad Sci (Paris)*, Vol. 248, No. 11, pp. 1721-1722, ISSN 0764-4442
- Lopez-Perez, R., Borges-Yanez, S.A., Jimenez-Garcia, G. & Maupome, G. (2002). Oral hygiene, gingivitis, and periodontitis in persons with Down syndrome. *Spec Care Dentist*, Vol. 22, No. 6, pp. 214-220, ISSN 1754-4505
- Lott, I.T. & Dierssen, M. (2010). Cognitive deficits and associated neurological complications in individuals with Down's syndrome. *Lancet Neurol*, Vol. 9, No. 6, pp. 623-633, ISSN 1474-4422
- Lowe, G. (1990). Dental problems. In: van Dyke, D.C., Lang, D.J., Heide, F., van Duyne, S. & Soucek, M.J., editors. *Clinical perspectives in the management of Down syndrome*. New York: Springer-Verlag, pp. 72-79, ISBN 038796987X.
- Mitchell, R.B., Call, E. & Kelly, J. (2003). Diagnosis and therapy for airway obstruction in children with Down syndrome. *Arch Otolaryngol Head Neck Surg*, Vol. 129, No. 6, pp. 642-645 ISSN 0886-4470

- Martin, G.E., Klusek, J., Estigarribia, B. & Roberts, J.E. (2009). Language characteristics of individuals with Down Syndrome. *Top Lang Disord*, Vol. 29, No. 2, pp. 112-132, ISSN 0271-8294
- Modeer, T., Barr, M. & Dahllof, G. (1990). Periodontal disease in children with Down's syndrome. *Scand J Dent Res*, Vol. 98, No. 3, pp. 228-234, ISSN 0029-845X
- Ondarza, A., Jara, L., Bertonati, M.I. & Blanco, R. (1995). Tooth malalignments in Chilean children with Down syndrome. *Cleft Palate Craniofac J*, Vol. 32, No. 3, pp. 188-193, ISSN 1545-1569
- Ondarza, A., Jara, L., Munoz, P. & Blanco, R. (1997). Sequence of eruption of deciduous dentition in a Chilean sample with Down's syndrome. *Arch Oral Biol*, Vol. 42, No. 5, pp. 401-406, ISSN 0003-9969
- Orner, G. (1971). Congenitally absent permanent teeth among mongols and their sibs. *J Ment Defic Res*, Vol. 15, No. Pt 4, pp. 292-302, ISSN 0022-264X
- Orner, G. (1975). Dental caries experience among children with Down syndrome and their sibs. *Arch Oral Bio*, Vol. 20, No. 10, pp. 627-634, ISSN 0003-9969
- Orner, G. (1976). Periodontal disease among children with Down's Syndrome and their siblings. *J Dent Res*, Vol. 55, No. 5, pp. 778-782, ISSN 0022-0345
- Rajić, Z. & Mestrovic, S.R. (1998). Taurodontism in Down's syndrome. *Coll Antropol*, Vol. 22 Suppl: pp. 63-67, ISSN 0350-6134
- Randell, D.M., Harth, S. & Seow, W.K. (1992). Preventive dental health practices of non-institutionalized Down syndrome children: a controlled study. *J Clin Pediatr Dent*, Vol. 16, No. 3, pp. 225-229, ISSN 1053-4628
- Reuland-Bosma, W. & van Dijk, L.J. (1986). Periodontal disease in Down's syndrome; A review. *J Clin Periodontol*, Vol. 13, No. 1, pp. 64-73, ISSN 0303-6979
- Russell, B.G. & Kjaer, I. (1995). Tooth agenesis in Down syndrome. *Am J Med Genet*, Vol. 55, No. 4, pp. 466-471, ISSN 1096-8628
- Sandström, A., Cressey, J. & Stecksén-Blicks, C. (2011). Tooth-brushing behaviour in 6-12 year olds. *Int J Paediatr Dent*, Vol. 21, No. 1, pp. 43-49, ISSN 0960-7439
- Sakellari, D., Belibasakis, G., Chadjipadelis, T., Arapostathis, K.N. & Konstantinidis A. (2001). Supragingival and subgingival microbiota of adult patients with Down's syndrome. Changes after periodontal treatment. *Oral Microbiol Immunol*, Vol. 16, No. 6, pp. 376-382, ISSN 0902-0055
- Sakellari, D., Arapostathis, K.N. & Konstantinidis, A. (2005). Periodontal conditions and subgingival microflora in Down syndrome patients. A case-control study. *J Clin Periodontol*, Vol. 32, No. 6, pp. 684-690, ISSN 0303-6979
- Saxen, L., Aula, S. & Westermarck, T. (1977). Periodontal disease associated with Down's Syndrome: An orthopantomographic evaluation. *J Periodontol*, Vol. 48, No. 6, pp. 337-340, ISSN 0022-3492
- Shott, S.R., Amin, R., Chini, B., Heubi, C., Hotze, S. & Akers, R. (2006). Obstructive sleep apnea: Should all children with Down syndrome be tested? *Arch Otolaryngol Head Neck Surg*, Vol. 132, No. 4, pp. 432-436, ISSN 0886-4470
- Scully, C. (1976). Down syndrome and dentistry. *Dental Update*, Vol. 3, No. 4, pp. 193-196, ISSN 0305-5000
- Shapira, J., Stabholz, A., Schnrr, D., Sela, M.N. & Mann, J. (1991). Caries levels, Streptococcus mutant counts, salivary pH and periodontal treatment needs of adult Down syndrome patients. *Spec Care Dentist*, Vol. 11, No. 6, pp. 248-251, ISSN 1754-4505
- Shapira, J., Chaushu, S. & Becker, A. (2000). Prevalence of tooth transposition, third molar agenesis and maxillary canine impaction in individuals with Down syndrome. *Angle Orthod*, Vol. 70, No. 4, pp. 290-296, ISSN 0003-3219

- Shaw, L. & Saxby, M.S. (1986). Periodontal destruction in Down syndrome and in juvenile periodontitis: how close a similarity? *J Periodontol*, Vol. 57, No. 11, pp. 709-713, ISSN 0022-3492
- Sherman, S.L., Allen, E.G., Bean, L.H. & Freeman, S.B. (2007). Epidemiology of Down syndrome. *Ment Retard Dev Disabil Res Rev*, Vol. 13, No. 3, pp. 221-227, ISSN 1080-4013
- Shyama, M., Al- Mutawa, S.A., Honkala, S. & Honkala, E. (2003). Supervised toothbrushing and oral health education program in Kuwait for children and young adults with Down syndrome. *Spec Care Dentist*, Vol. 23, No. 3, pp. 94-99, ISSN 1754-4505
- Siqueira Jr, W.L. & Nicolau, J. (2002). Stimulated whole saliva components in children with Down syndrome. *Spec Care Dentist*, Vol. 22, No. 6, pp. 226-230, ISSN 1754-4505
- Skrinjarić, T., Glavina, D. & Jukić, J. (2004). Palatal and dental arch morphology in Down syndrome. *Coll Antropol*, Vol. 28, No.2, pp. 841-847, ISSN 0350-6134
- Stabholz, A., Mann, J., Sela, M., Schurr, D., Steinberg, D. & Shapira, J. (1991). Caries experience, periodontal treatment needs, salivary pH, and *Streptococcus mutans* counts in a preadolescent Down syndrome population. *Spec Care Dentist*, Vol. 11, No. 5, pp. 203-208, ISSN 1754-4505
- Townsend, G.C. (1983). Tooth size in children and young adults with trisomy 21 (Down syndrome). *Arch Oral Biol*, Vol. 28, No. 2, pp. 159-166, ISSN 0003-9969
- Townsend, G.C. (1987). A correlative analysis of dental crown dimensions in individuals with Down syndrome. *Hum Biol*, Vol. 59, No. 3, pp. 537-548, ISSN 0018-7143
- Ulseth, J.O., Hestnes, A., Stovner, L.J. & Storhaug, K. (1991). Dental caries and periodontitis in persons with Down Syndrome. *Spec Care Dentist*, Vol. 11, No. 2, pp. 71-73, ISSN 1754-4505
- van Dyke, D.C., Lang, D.J., Miller, J.D., Heide, F., van Duyne, S. & Chang, H. (1990). Common medical problems. In: van Dyke, D.C., Lang, D.J., Heide, F., van Duyne, S. & Soucek, M.J., editors. *Clinical perspectives in the management of Down syndrome*. New York: Springer-Verlag, pp. 3-14, ISBN 038796987X.
- Vigild, M. (1985). Prevalence of malocclusion in mentally retarded young adults. *Community Dent Oral Epidemiol*, Vol. 13, No. 3, pp. 183-184, ISSN 0301-5561
- Vigild, M. (1986). Dental caries experience among children with Down's syndrome. *J Ment Defic Res*, Vol. 30, No. Pt3, pp. 271-276, ISSN 0022-264X
- Waldman, H.B., Hasan, F.M. & Perlman, S. (2009). Down syndrome and sleep-disordered breathing: the dentist's role. *J Am Dent Assoc*, Vol. 140, No. 3, pp. 307-312, ISSN 0002-8177
- Westerman, G.H., Johnson, R. & Cohen, M.M. (1975). Variations of palatal dimensions in patients with Down's syndrome. *J Dent Res*, Vol. 54, No. 4, pp. 767-771, ISSN 0029-845X
- Yam WK, Tse PW, Yu CM, Chow CB, But WM, Li KY, Lee LP, Fung EL, Mak PP, Lau JT. (2008). Medical issues among children and teenagers with Down syndrome in Hong Kong. *Downs Syndr Res Pract*, Vol.12, No. 2, pp. 138-140, ISSN 1753-7606
- Yoshihara, T., Morinushi, T., Kinjyo, S. & Yamasaki, Y. (2005). Effect of periodic preventive care on the progression of periodontal disease in young adults with Down's syndrome. *J Clin Periodontol*, Vol. 32, No. 6, pp. 556-560, ISSN



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This book provides a concise yet comprehensive source of current information on Down syndrome. Research workers, scientists, medical graduates and paediatricians will find it an excellent source for reference and review. This book focuses on exciting areas of research on prenatal diagnosis - Down syndrome screening after assisted reproduction techniques, noninvasive techniques, genetic counselling and ethical issues. Whilst aimed primarily at research worker on Down syndrome, we hope that the appeal of this book will extend beyond the narrow confines of academic interest and be of interest to a wider audience, especially parents and relatives of Down syndrome patients.

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