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Learning, 2004 (Stainless Steel Wire; Height: 40 cm)
With permission from Mr Victor Tan Wee Tar

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Letter from the Editor

The face is our window to the world and the oral cavity enables the alimentary canal to receive food and saliva. Any oro-facial anomaly or dysfunction is an immediate concern to the patient and attending dental surgeons. Two Case Reports described the heartening works of local dentists in the maxilla-facial prosthodontic treatment of a large maxillary defect after cancer treatment and a young patient's auricular defect.

The Ministry of Health has set up a Fluoride Review Committee to review the fluoridation of drinking water in Singapore. An earlier study of about 1,800 Singaporean pre-schoolers had revealed less successful caries control in the pre-schoolers. About 40% of the pre-schoolers had caries. The children of the lower socio-economic group appeared to carry the major burden of the disease. The Review Article on Fluoride use and dental caries control in Singapore discussed the various possible approaches to address this inequality of dental caries.

SDJ readers will also find a richly detailed and engrossing report of the Singapore Armed Force Dental Project Team's mission to Afghanistan. In a land that knows little dentistry, the team set up the first modern dental clinic in the Bamiyan Province of Afghanistan. Besides delivering dental care to the local populations, they also trained the Afghan dental team to later take over the clinic. The DPT was deployed to the New Zealand Defence Force (NZDF) camp located south of the main town of Bamiyan. The multiple casualties suffered by NZDF last year from a roadside bomb showed that the mission was not completely without risks.

The front cover features the wire sculpture of the partially blind Singaporean sculptor, Victor Tan Wee Tar. The medium of stainless steel wire, used for figuration, was innovated by Victor Tan in the mid-90s when he was studying in the LaSalle-SIA College of the Arts. Hope you will enjoy this issue of the *SDJ*.

Dr. Peng Hui Tan
Editor-in-Chief

Review Article

A Rational Approach to Dental Management of Patients on Bisphosphonates

Juen Bin Lai and Choy Yoke Poon

Department of Oral and Maxillofacial Surgery, National Dental Centre Singapore, Singapore.

Abstract

There has been a lot of focus on osteonecrosis of the jaws associated with the usage of bisphosphonates both in dental and medical literature in recent years. However, the exact pathogenesis of bisphosphonate-related osteonecrosis of the jaws remains unclear. Against the background of emerging evidence of an evolving condition, it is not surprising that there is a lack of robust evidence-based recommendations on dental treatment of patients on bisphosphonates. This paper seeks to provide a rational approach to the dental management of patients on bisphosphonates based on current literature. [*Singapore Dent J* 2011;32(1):1–13]

Key Words: bisphosphonates, osteonecrosis

Introduction

Bisphosphonates are used to treat osteoporosis, multiple myeloma, metastatic neoplasms with skeletal involvement, Paget's disease of bone, other metabolic bone diseases. Bisphosphonates come in intravenous (IV) and oral forms. IV bisphosphonates are used for multiple myeloma and metastatic neoplasms with skeletal involvement while the oral bisphosphonates are used mainly for osteoporosis. However, IV bisphosphonate (zoledronic acid) has recently been administered once yearly to treat osteoporosis.[1] The pharmacologic characteristics and the usual dosing of the bisphosphonates are described in Table 1.

Bisphosphonates are analogues of inorganic pyrophosphates that have a high affinity for hydroxyapatite crystals.[10,11] They are incorporated into the skeleton without being degraded and are remarkably persistent drugs. Aminobisphosphonates which contain nitrogen side chain have much higher potency and longer half-life compared to nonaminobisphosphonates. The estimated half-life for alendronate is up to 12 years.[12] The potency of bisphosphonate is usually compared relative to etidronate which is the least potent non-nitrogen containing bisphosphonate. Zoledronic acid is the most potent of the group and is 10,000 more potent relative to etidronate. This is followed by pamidronate with relative potency of 1,000–5,000 and alendronate with relative potency of 1,000.

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Mechanisms of Action of Bisphosphonate

Bisphosphonates are powerful inhibitors of osteoclast activity. They cause the induction of non-hydrolyzable adenosine triphosphate analogue that induces cellular apoptosis and inhibition of farnesyl diphosphonate synthase which disrupts cholesterol synthesis resulting in dysregulation of intracellular transport, cytoskeletal organization and cell proliferation. This leads to inhibition of osteoclast function, reduce osteoclast recruitment, and induce osteoblastic production of osteoclast-inhibiting factor.[13–15]

Table 1. Characteristics of bisphosphonates available

Drug	Route of administration	Nitrogen containing	Relative potency	Indication and usual dosage
Etidronate[2]	Oral	No	1	Paget's disease: 5–20 mg/kg/day × 3–6 mo
Tiludronate[3]	Oral	No	50	Paget's disease: 400 mg/day × 3 mo
Alendronate[4]	Oral	Yes	1,000	Osteoporosis treatment: 70 mg once/wk Osteoporosis prophylaxis: 35 mg once/wk Paget's disease: 40 mg/day × 6 mo
Risedronate[5]	Oral	Yes	1,000	Osteoporosis treatment and prophylaxis: 35 mg once/wk Paget's disease: 30 mg/day × 2 mo
Ibandronate[6,7]	Oral or intravenous	Yes	1,000	Osteoporosis treatment: 150 mg orally once/mo or intravenous 3 mg intravenously every 3 mo
Pamidronate[8]	Intravenous	Yes	1,000–5,000	Hypercalcemia of malignancy: 60–90 mg × 1 dose Paget's disease: 30 mg/day × 3 days Osteolytic bone metastases: 90 mg every 3–4 wks
Zoledronic acid[9]	Intravenous	Yes	10,000	Hypercalcemia of malignancy: 4 mg × 1 dose Multiple myeloma/bone metastases: 4 mg every 3–4 wks Paget's disease: 5 mg × 1 dose Osteoporosis treatment: 5 mg once/yr

Bisphosphonate Related Osteonecrosis of Jaws

The first report which described bisphosphonate related osteonecrosis of jaws (BRONJ) was in 2003 by Marx.[16] He observed painful exposed bone in mandible, maxilla or both jaws in 36 patients who were treated with intravenous bisphosphonates. Subsequently, more reports on bisphosphonate-associated osteonecrosis of jaws were published (Table 2). Yeo et al[17] reported five cases of bisphosphonate-related osteonecrosis of the jaws in Singapore.

Pathogenesis of BRONJ

Despite the numerous publications, the pathogenesis of BRONJ remains elusive. It is obvious that in BRONJ the problem occurs in the bone but studies have indicated that the soft tissue of the oral mucosa may also be involved. It has been proposed that bisphosphonates, which accumulate in the bone, have direct toxic effects on the oral epithelium and inhibit normal healing of soft tissue lesions caused by either dental extractions or some other trauma.[64,65] The failure of soft tissue to heal would result in the exposure of the bone, which then becomes necrotic.

There are a number of hypotheses associated with the pathogenesis of BRONJ.

Suppression of bone remodelling

Nearly every report on BRONJ alludes to bisphosphonate-induced bone remodeling suppression as a likely mechanism. Osteoclasts are the main cellular target of bisphosphonates and osteoclast-mediated bone remodeling is suppressed through disruption of intracellular pathways. It has been

Table 2. Summary of case reports and case series of bisphosphonate related osteonecrosis of the jaws

Study, Year (Reference)	No. of patients	Sex (Male/ Female)	Primary diagnosis	Sites of BRONJ	Cause of BRONJ	Medications
1. Ruggiero et al, 2004[18]	63	18 (M)/45 (F)	Myeloma (28) Breast cancer (21) Other malignancy (7) Osteoporosis (7)	Mandible (39) Maxilla (23) Both jaws (1)	Procedure (54) Spontaneous (9)	Zoledronic acid (9) Pamidronate & zoledronic acid (13) Pamidronate (34) Alendronate (5) Risedronate (1) Alendronate & zoledronic acid (1)
2. Marx et al, 2005[19]	119	Not reported	Myeloma (62) Breast cancer (50) Prostate cancer (4) Osteoporosis (3)	Mandible (81) Maxilla (33) Both jaws (5)	Procedure (55) Periodontal disease (34) Spontaneous (30)	Zoledronic acid (48) Pamidronate & zoledronic acid (36) Pamidronate (32) Alendronate (3)
3. Migliorati et al, 2005[20]	18	4 (M)/14 (F)	Myeloma (3) Breast cancer (10) Other malignancy (4) Osteopenia (1)	Mandible (8) Maxilla (2) Both jaws (1) Not reported (7)	Procedure (7) Spontaneous (1) Oral trauma (1) Not reported (9)	Zoledronic acid (8) Pamidronate & zoledronic acid (6) Pamidronate (3) Alendronate (1)
4. Bamias et al, 2005[21]	17	10 (M)/7 (F)	Myeloma (11) Breast cancer (2) Other malignancy (4)	Mandible (14) Maxilla (3)	Procedure (13) Spontaneous (2) Dentures (2)	Zoledronic acid (7) Pamidronate & zoledronic acid (9) Zoledronic acid & ibandronate (1)
5. Pires et al, 2005[22]	12	3 (M)/9 (F)	Myeloma (4) Breast cancer (6) Other malignancy (2)	Mandible (8) Maxilla (3) Both jaws (1)	Procedure (8) Not reported (4)	Zoledronic acid (3) Pamidronate & zolendronic acid (5) Pamidronate (4)
6. Melo et al, 2005[23]	11	7 (M)/4 (F)	Myeloma (7) Breast cancer (3) Other malignancy (1)	Mandible (8) Maxilla (2) Both jaws (1)	Procedure (9) Spontaneous (1) Dentures (1)	Zoledronic acid (4) Pamidronate & zolendronic acid (3) Pamidronate (4)
7. Farrugia et al, 2006[24]	23	7 (M)/16 (F)	Myeloma (9) Breast cancer (6) Other malignancy (3) Osteoporosis (4) Paget's disease (1)	Mandible (12) Maxilla (10) Both jaws (1)	Procedure (9) Spontaneous (14)	Zoledronic acid (11) Pamidronate & zoledronic acid (3) Pamidronate (4) Alendronate (5)

(Contd)

Table 2. Continued

Study, year (Reference)	No. of patients	Sex (Male/ Female)	Primary diagnosis	Sites of BRONJ	Cause of BRONJ	Medications
8. Thakkar et al, 2006[25]	17	13 (M)/4 (F)	Myeloma (15) Other malignancy (2)	Not reported (7)	Procedure (3) Not reported (14)	Zoledronic acid (7) Pamidronate & zoledronic acid (6) Pamidronate (4)
9. Wutzl et al, 2006[26]	17	8 (M)/9 (F)	Myeloma (12) Breast cancer (4) Other malignancy (1)	Mandible (9) Maxilla (8)	Procedure (13) Spontaneous (4)	Zoledronic acid (11) Pamidronate & zoledronic acid (2) Pamidronate (4)
10. Graziani et al, 2006[27]	14	1 (M)/13 (F)	Breast cancer (11) Other malignancy (3)	Mandible (6) Maxilla (7) Both jaws (1)	Procedure (9) Spontaneous (5)	Zoledronic acid (14)
11. Zarychanski et al, 2006[28]	12	7 (M)/5 (F)	Myeloma (10) Breast cancer (1) Other malignancy (1)	Mandible (10) Maxilla (1) Both jaws (1)	Procedure (7) Spontaneous (2) Dentures (2) Tooth abscess (1)	Pamidronate (12)
12. Dimitrakopoulos et al, 2006[29]	11	5 (M)/6 (F)	Myeloma (5) Other malignancy (6)	Mandible (7) Maxilla (3) Both jaws (1)	Procedure (7) Spontaneous (3) Dentures (1)	Zoledronic acid (6) Pamidronate & zolendronic acid (4) Pamidronate, zoledronic acid & ibandronate (1)
13. Clarke et al, 2007[30]	25	15 (M)/10 (F)	Myeloma (20) Breast cancer (1) Other malignancy (2) Osteoporosis (2)	Mandible (19) Maxilla (6)	Procedure (11) Spontaneous (10) Not reported (4)	Zoledronic acid (5) Pamidronate & zoledronic acid (8) Pamidronate (10) Alendronate (2)
14. Dannemann et al, 2007[31]	23	12 (M)/11 (F)	Myeloma (10) Breast cancer (7) Other malignancy (3) Osteoporosis (3)	Mandible (17) Maxilla (4) Both jaws (2)	Procedure (21) Oral ulcer (1) Oral prosthesis (1)	Zoledronic acid (14) Pamidronate & zolendronic acid (5) Pamidronate (1) Alendronate (3)
15. Diego et al, 2007[32]	10	6 (M)/4 (F)	Myeloma (2) Breast cancer (1) Other malignancy (7)	Mandible (6) Maxilla (3) Both jaws (1)	Procedure (10)	Zoledronic acid (10)
16. Summary of studies with fewer than	102	39 (M)/63 (F)	Myeloma (41) Breast cancer (27)	Mandible (60) Maxilla (31)	Procedure (83) Spontaneous (12)	Zoledronic acid (45) Pamidronate & zoledronic acid (21) Pamidronate (21)

10 patients[17,33–63]	Other malignancy (18)	Both jaws (8)	Dentures (1)	Alendronate (12)
	Osteoporosis (11)	Not reported (2)	Not reported (5)	Risedronate (2)
	Paget's disease (3)	Hard palate (1)	Oral ulcer (1)	Disodium clodronate (1)
	Osteopenia (2)			Zolendronic acid & ibandronate (1)
				Alendronate and concomitant i.v. bisphosphonate (pamidronate and zoledronic acid sequentially) (1)

shown that the intracortical remodeling rates of the jaws are 10–20 times higher than that of the iliac crest.[66,67] This hypothesis suggests bisphosphonate activity may be excessive in the metabolically active jaws leading to bone necrosis which quickly becomes exposed bone when the thin overlying mucosa breaks down due to minor trauma or dental extractions.

Suppression of bone vasculature

Before the emergence of BRONJ, much of what was known concerning osteonecrosis centered on the two following conditions that manifest as a result of disruption of the vasculature. They are avascular necrosis of the hip and osteoradionecrosis. Avascular necrosis of the hip occurs as a result of disruption of the vasculature.[68] Similarly, osteoradionecrosis, most prominently of the jaw, occurs after radiation-induced disruption of the vasculature.[69–71] The existence of these conditions, and the clear role of disrupted vasculature in their pathophysiology, has led to the hypothesis that the vasculature plays a similar role in the pathophysiology of BRONJ. Numerous studies have documented antiangiogenic effects of bisphosphonates *in vitro*.[72,73] However, there have been no studies assessing the vascular pattern in BRONJ.

Infection as a contributory factor

It is believed that infection could contribute to BRONJ by enhancing osteoclast-independent bone resorption. Typically, the exposed bone is secondarily infected by *Actinomyces* species and other microflora in the oral cavity. BRONJ tissue consistently shows a prevalence of scalloped bone surface,[69,74,75] a seemingly paradoxical feature, given the suppressive effect of bisphosphonates on bone resorption. Bacteria and associated fibroblast-like cells have the capacity to directly resorb bone independent of osteoclasts by liberating various acids and proteases.[76–78] Because osteoclasts signal osteoblasts during normal bone remodeling,[79,80] resorption that occurs independent of osteoclasts would likely lack osteoblast-mediated bone formation. Such resorption could factor into the pathogenesis of BRONJ.

Pathophysiological cofactors

Various cofactors are associated with BRONJ such as comorbidities (e.g. diabetes[81]), lifestyle

factors (e.g. smoking and obesity[82]), interventions (e.g. dental extraction[83]), and concurrent medications (e.g. corticosteroids) have all been associated with BRONJ. These cofactors individually do not cause bone necrosis of the jaws but in the presence of bisphosphonates play a significant role in the pathophysiology of BRONJ.

Incidence of BRONJ

The incidence of BRONJ with intravenous bisphosphonate ranges from 0.8% to 12%.[84–92] Oral bisphosphonate is associated with lower incidence of BRONJ ranging from 0.01% to 0.04%.[83] This increases to 0.09%–0.34% following extractions.

Radiologic Finding of BRONJ

The radiologic findings of BRONJ are not specific and mimic other conditions such as osteomyelitis, osteoradionecrosis, cancer metastasis and Paget's disease. Periapical radiograph and orthopantogram findings include thickening of the lamina dura, osteolysis, diffuse sclerosis, narrowing of the mandibular canal and poor healing or non-healing of extraction sites.[93–95]

Definition and Staging of BRONJ

There are various names to this condition. The American association of oral and maxillofacial surgeons refer this type of osteonecrosis as "bisphosphonate related osteonecrosis of the jaws"[96] and the Academy of Oral Medicine refers this as "bisphosphonate-associated osteonecrosis of the jaws".[97] Marx prefers to call this condition as "bisphosphonate-induced osteonecrosis of the jaws".[98]

In this article, we will use the definition proposed by the American Association of Oral and Maxillofacial surgeons. BRONJ[96] is defined as the exposed necrotic bone in the maxillofacial region that has persisted for more than eight weeks in patients with current or previous treatment with a bisphosphonate and with no history of radiation therapy to the jaws. It is a serious and debilitating condition affecting the jaws.

There are four stages of BRONJ, which are as follows:

Stage 0 defines signs and symptoms short of exposed necrotic bone in patients that might indicate a histological necrosis or a prenecrotic state.

Stage 1 defines exposed/necrotic bone in patients who are asymptomatic and have no evidence of infection.

Stage 2 defines exposed/necrotic bone in patients with pain and clinical evidence of infection.

Stage 3 defines exposed/necrotic bone in patients with pain, infection and one or more of the following: pathologic fracture, extra-oral fistula, or osteolysis extending to the inferior border.

Strategy for Management of Patients on Bisphosphonates

Identification of patients at risk of BRONJ

It appears that certain patients are more at risk of BRONJ development. Low risk patients can be treated in general dental practice settings while high risk patients may be referred to an oral and maxillofacial surgeon or dental specialist who has experience in managing such patients.

High-risk patients include:

- Cancer patients on intravenous bisphosphonate
- Patients on bisphosphonate therapy with exposure to chemotherapeutic agents (i.e. cyclophosphamide, erythropoietin, thalidomide and steroids)
- Patients on oral bisphosphonate for more than 3 years
- Patients on bisphosphonate and smoking
- Patients on bisphosphonate and other systemic medical conditions (i.e. cancer, diabetes, obesity, atherosclerotic heart disease)

Prevention of BRONJ

Prior to bisphosphonate therapy

A preventive regime should be instituted for patients who are about to start intravenous bisphosphonates for oncologic reasons. The dentition is assessed for carious lesions, defective restorations, vitality and periapical lesions. The

periodontium (pocketing, furcation involvement, bleeding on probing, suppuration, mobility) is also examined. The patient's oral hygiene (plaque, calculus accumulation) is recorded. Oral mucosa and alveolar processes are checked for infection, ulcerations, hyperplasia, bony spicules and exostoses. If patients are edentulous or partially edentulous with removable prostheses, the prostheses are checked for fit, retention, stability and hygiene. Ill-fitting dentures can cause trauma and ulcerations to the oral mucosa and initiate BRONJ. Baseline dental radiographs in forms of orthopantograms, bitewings, selective periapical radiographs are required for the detection of occult caries and any other pathology, such as cysts, buried teeth or roots.

Dental clearance involves the treatment of active oral infections, elimination of sites at high risk for infection (e.g. removal of partially impacted wisdom teeth, unsalvageable teeth, non-restorable teeth, teeth with substantial periodontal bone loss). Removal of tori and bony exotosis are indicated especially when patients are wearing or will be wearing removable prostheses as these are sites at risk of bone exposure and initiation of BRONJ. Ill-fitting dentures are adjusted and fabrication of new dentures may be indicated if existing dentures are beyond salvage. It is important that the new dentures do not cause mucosal ulcerations.

All invasive dental procedures should be completed prior to the start of intravenous bisphosphonate. Bisphosphonate therapy should be delayed, if systemic condition permits, until the extraction site has epithelialized (14–21 days) or until there is adequate osseous healing. After the initial dental clearance, it is important to provide routine dental care afterwards. It is advisable to perform oral examination and dental cleaning six monthly. Constant surveillance of the oral cavity is important to detect any bone exposure so that it can be treated early. Oral hygiene in forms of tooth brushing, flossing and rinsing with fluoride-containing mouth rinses, are reinforced. Diet counseling in patient with high caries risk, patient education and motivation are important to prevent future caries and periodontal diseases development and progression in the remaining dentition. All these non-invasive dental procedures can be carried out in general dental practice setting.

Currently on bisphosphonate therapy

For patients who are already on intravenous bisphosphonates, maintenance and conservative dental care are performed as far as possible. Conservative measures remain the treatment of choice in order to avoid dentoalveolar surgery, periodontal surgery and extractions if possible to reduce the risk of BRONJ development. Non-restorable teeth can be treated by decoronation and endodontic treatment.

Patients who are receiving oral bisphosphonate therapy, routine dental care is encouraged. Elective dentoalveolar surgery and extractions are not contraindicated, provided the necessary precautions are taken. For patients on oral bisphosphonate therapy for more than 3 years with or without concomitant steroid medication, discontinuation of oral bisphosphonate 3 months prior to oral surgery should be considered in consultation with the prescribing physician if the systemic condition permits and resumed after osseous healing has occurred. Patients with concomitant steroid medication are known to be at a slightly higher risk of BRONJ and should be informed accordingly.

For patients on oral bisphosphonate therapy less than 3 years without concomitant steroid medication and have no clinical risk factors, dentoalveolar surgery and extractions can proceed without any alterations. For patients on oral bisphosphonate therapy less than 3 years with concomitant steroid medication, a 3-month drug holiday should be considered, in consultation with the prescribing physician.

Biochemical test to assess risk for BRONJ in patient on bisphosphonate

Biochemical bone turnover markers are released during bone remodeling and can provide a measure of the rate of bone metabolism. One of these bone turnover markers is serum C-terminal telopeptide (CTX). Serum CTX measures the serum level of the C-terminal telopeptide-related fragment from a cross-linking chain in type I collagen, which is cleaved by the osteoclast in bone resorption. CTX is a measure of the bone resorption activity and is used as a predictor of bone mineral density (BMD) response to bisphosphonate therapy.[99]

Marx and Ranjit[100,101] reported the use of CTX in predicting the risk of BRONJ related to oral

bisphosphonate use. Marx studied a series of 30 patients who were on oral bisphosphonate therapy and correlated them with their serum CTX. He concluded that patients with serum CTX less than 100 pg/mL representing high risk of BRONJ, values between 100 and 150 pg/mL representing moderate risk and values above 150 pg/mL representing minimal risk. Further validation studies are required. As its reliability remains controversial the American Association of Oral and Maxillofacial Surgeons position paper did not include the use of CTX on the management of bisphosphonate-related osteonecrosis of the jaws.

Management of BRONJ

The treatment goals of established BRONJ are to eliminate pain, control infection of the soft and hard tissues and minimise the progression or occurrence of bone necrosis.

Patient with BRONJ stage 0
The management of stage 0 patients is essentially preventive and avoids invasive oral surgical procedures and dental extractions as far as possible.

Patient with BRONJ stage 1
The management of stage 1 patients is mainly conservative. It includes oral antibacterial mouth rinse, adjustment of dentures to minimise soft tissue trauma or irritation, patient education, regular quarterly follow-up. Long-term discontinuation of bisphosphonate should be considered if the patient's systemic condition permits after discussing with prescribing physician.

Patient with BRONJ stage 2
The treatment of stage 2 patients includes the use of oral antibacterial mouth rinse, analgesia for pain control, superficial debridement and removal of loose sequestrum to relieve soft tissue irritation with minimal disruption to adjacent soft tissue and underlying bone and antibiotic therapy for the superinfection. Cultures, including those for aerobic and anaerobic bacteria may be collected to determine the appropriate antimicrobial intervention. The possibility of long-term discontinuation of bisphosphonate if systemic condition permits should be considered after consulting with the prescribing physician. The infection is usually treated with empirical broad-spectrum oral antibiotics such as penicillin V or amoxicillin. If patient is allergic to penicillin, clindamycin can be used. Other alternative antibiotics include erythromycin ethylsuccinate, doxycycline together with metronidazole, levofloxacin and moxifloxacin. Once the culture and sensitivity result is available, specific antibiotic therapy should be instituted.

Patient with BRONJ stage 3
The management of stage 3 patients is essentially similar to that of stage 2 patients. More aggressive surgical debridement or resection to achieve longer term palliation of infection and pain may be necessary. The effectiveness of hyperbaric oxygen therapy is still undetermined.

Examples of Local Cases With BRONJ

Case 1
A 60 year-old Chinese female presented with non-healing socket over upper right canine region of 4-month duration. She also complained of recurrent epitaxis from the right nose. ENT examination was unremarkable. She was diagnosed with osteoporosis and has been on oral alendronate (Fosamax) for the past 4 years.

Clinical examination revealed sinus tract over upper right canine region (Figure 1). Anterior maxillary occlusal showed radiolucent defect over the above region (Figure 2).

Fosamax was discontinued. She underwent surgical debridement and exploration under local anaesthesia. Figure 3 showed sequestrum with defect from alveolar ridge to right piriform rim. Tissues were submitted for histology and results showed sequestrum which is consistent with BRONJ given the medical history. She was reviewed and the region healed uneventfully 1 year later.

Case 2
A 59 years-old Malay female with medical history of breast cancer with bone metastasis presented with stage II BRONJ over left lower posterior ridge. She developed 3 mm of exposed bone after eight doses of IV bisphosphonate zoledronic acid (Zometa) and oral chemotherapy. IV bisphosphonate was discontinued and BRONJ

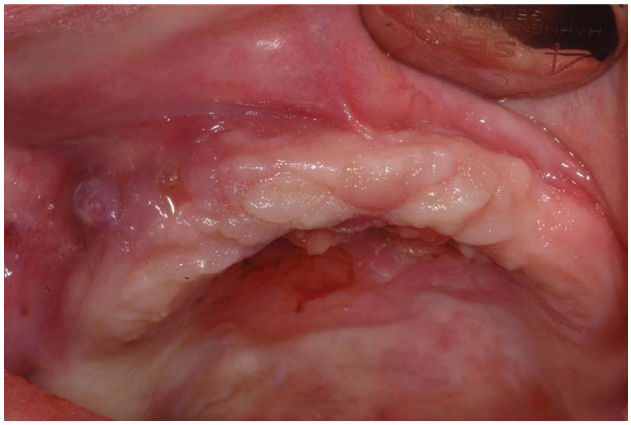

Figure 1. *Sinus tract over upper right canine region.*

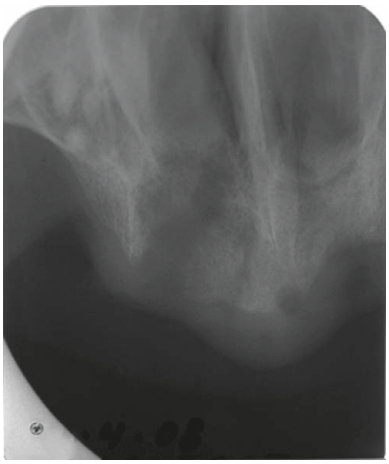

Figure 2. *X-ray showing lytic lesion secondary to BRONJ.*

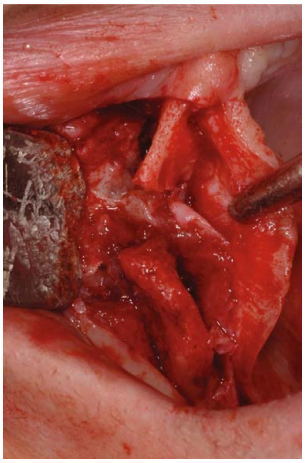

Figure 3. *Sequestrum and granulation tissue.*

was resolved 3 months after cessation of the medication. Figure 4 showed radiolucent and lytic appearance and Figure 5 showed the healed region with normal cortical outline.

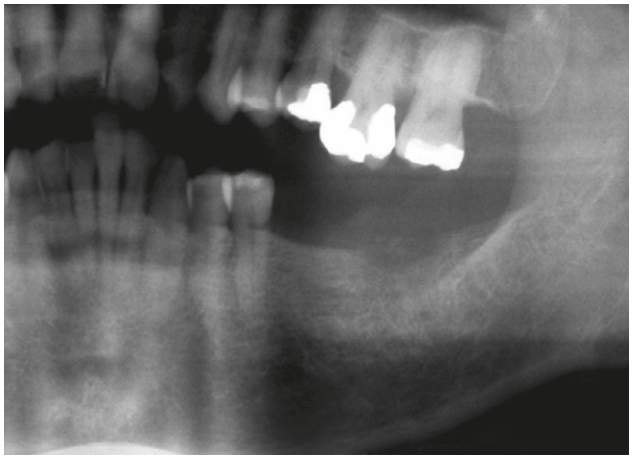

Figure 4. *Lytic region with BRONJ over posterior alveolar crest.*

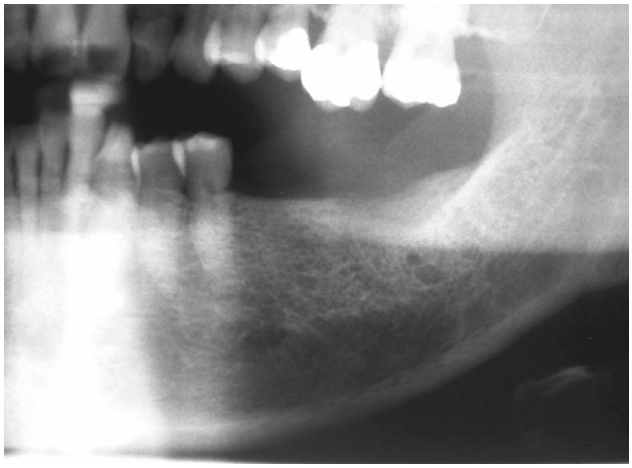

Figure 5. *Resolution of the lesion after 3 months bisphosphonate cessation.*

Case 3

A 45-year-old Chinese female with medical history of breast cancer with bone metastasis presented with exposed bone and multiple sinus tracts over the right maxilla. She was treated with IV bisphosphonate zoledronic acid (Zometa). She was diagnosed with stage III BRONJ over the right maxilla (Figure 6) and was not responsive to conservative treatment. Right maxillectomy was performed to alleviate pain for the patient. Figure 7 showed the resected right maxillary bone sequestrum.

Conclusion

Patients on bisphosphonate therapy may develop BRONJ which is a rare but debilitating condition.

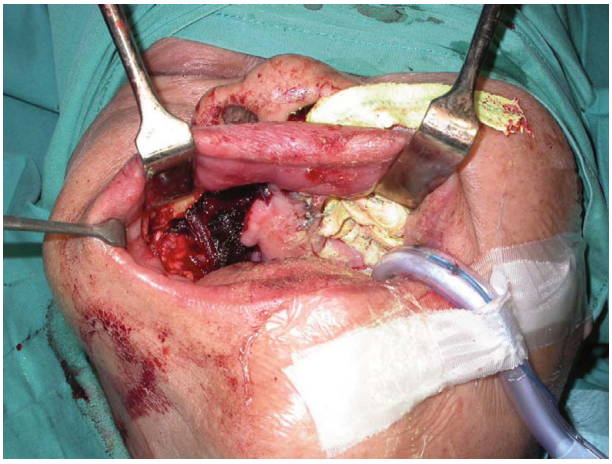

Figure 6. *Stage III BRONJ requiring right maxillectomy.*

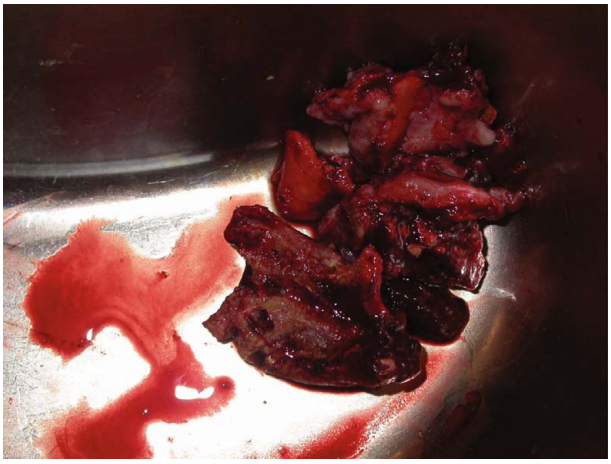

Figure 7. *Sequestrum from right maxilla.*

BRONJ is difficult to treat and patients may even require jaw resection to palliate the infection and pain. Therefore, it is important for the dental community to be familiar with the management of these patients in collaboration with our medical colleagues.

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Review Article

A Review of the Uses of Fluoride and Outcomes of Dental Caries Control in Singapore

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Abstract

In 1958, Singapore was the first country in Asia to implement a community water fluoridation program covering 100% of its population. There were no reports of anti-fluoridation activities or calls for referenda then; and at present, there is only mild opposition to water fluoridation. The water was initially fluoridated at 0.7 ppm but was gradually adjusted downwards to 0.6 ppm in January 1992, with a further reduction to 0.5 ppm in January 2008 where it has since remained unchanged. Fluoride varnishes and gels are also available for use by the professional for judicious application in individuals who are at high-risk of dental caries. In addition, fluoridated dentifrices and mouth rinses are also readily available over the counter for home use.

In addition to the use of fluorides, the following factors also contribute to the high level of oral health in Singapore: (i) a highly educated populace; (ii) public health education to increase awareness and literacy is routinely carried out by the Health Promotion Board; (iii) the School Dental Service provides 'free' dental care to school children up to 18 years of age; and (iv) primary dental care is also readily accessible by the general public by an extensive network of private and public sector dental clinics. [*Singapore Dent J* 2011;32(1):14–18]

Key Words: dental caries, fluoride, Singapore, water fluoridation

Introduction

Singapore is a small and compact island nation measuring 710.2 km^2 lying off the southern tip of Peninsular Malaysia. Its total population stands at 5.08 million comprising 74.4% (3.77 million) residents and 25.6% (1.30 million) of an expatriate workforce.[1]

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With no natural resources of its own, Singapore relies primarily on its strategic location and manpower for economic growth. Its major industries are finance, trade, manufacturing, and tourism and more recently information technology and biomedical research and development.

Today the nation is ranked among the top 10 global cities in the world alongside New York, London, Tokyo, Hong Kong, and Sydney in terms of economic, political, cultural, and infrastructural development.[2] WHO has also ranked Singapore's healthcare system the sixth in the world based on overall health system performance.[3]

Singapore's current per capita GDP is US$36,537 and has a healthcare budget of 4.0% of the GDP. Dental healthcare, however, comprises only 2.5% of the overall healthcare budget.

This article reports on the uses of fluoride in Singapore, outcomes in dental caries control, and challenges that lie ahead.

Community Water Fluoridation

Loh[4] reported that the prevalence of dental caries in school children was as high as 95% in the 1940s and early 1950s. The School Dental Service was established in 1949, in response to the high unmet dental needs of school children.[4] There were few dentists in Singapore in the early 1950s and dental auxiliaries (similar to the New Zealand type school dental nurse) were employed in the School Dental Service to provide cost-effective primary dental care.[4] The School Dental Service currently provides heavily subsidized dental treatment to all school going children 6–18 years of age.

The authorities at that time realized that the enormity of the scope presented by the prevalence of dental caries could not be managed by a purely restorative/curative approach.[4] Discussions to fluoridate the water supply were undertaken in the mid-1950s and the decision to implement water fluoridation was approved by the government in 1954. Fluoridation was first implemented on an experimental basis in May 1956 and by January 1958, the entire water supply of Singapore was fluoridated. There were no reports of anti-fluoridation activities or calls for referenda then.[4]

Singapore was the first country in Asia to implement a community water fluoridation program covering 100% of its population.[4] With universal coverage via a municipal water supply (in Singapore the Public Utilities Board is the only water utility), Singapore did not have to depend on other communal forms of fluoride delivery.

Based on the formula derived by Galagan and Vermillion,[5] Singapore's water was initially fluoridated at 0.7 ppm using a dry feeder distribution system and sodium silicofluoride as the derivative fluoride compound.[4] A 1989 study on the developmental defects of enamel (DDE) including fluorosis was conducted on 2,090 children aged between 11 and 13 years.[6] In this sample, it was reported that 83.3% of the children used fluoridated toothpaste before reaching 6 years of age; while 61.9% had no or questionable fluorosis, 26.6% had very mild fluorosis, and 10.5% mild fluorosis. This was a huge increase from the earlier findings of 1970, when it was reported that less than 5% of children had a very mild form of fluorosis.[7] The Community Fluorosis Index (CFI) based on the 1989 study[6] was 0.56, which was deemed to be bordering on a CFI of 0.60 (which may warrant consideration as a public health concern).[4]

The results of this study on DDE and fluorosis together with reports from the downward adjustment of the levels of fluoride in Hong Kong's drinking water from 1.0 ppm in 1967 to 0.7 ppm in 1978, and finally to 0.5 ppm in 1988 prompted the Ministry of Health to lower the fluoride levels from 0.7 to 0.6 ppm as of January 1992[4] and a further reduction to 0.5 ppm since January 2008 where it has remained unchanged. Since its implementation, water fluoridation has been the mainstay caries preventive measure in Singapore.

Professionally Applied Fluoride Products

Local guidelines concerning the use of professionally applied fluorides are similar to international practices, which is the judicious and selective use of these fluoride vehicles for patients at high risk of dental caries. These professionally applied fluoride vehicles include fluoride varnishes and gels. However, silver fluorides/silver diamine fluorides are not available locally and these have to be specially ordered from foreign vendors when required. Fissure sealants are also routinely placed for high risk children in the School Dental clinics which provide 'free' dental services to all (100%) school going children between 6 and 18 years of age.

Unfortunately, there are no local data on the availability, accessibility, affordability, and acceptability or coverage of the professionally applied and self-use forms of fluoride.

Self-use Fluoride Products

Fluoridated toothpastes and mouthrinses are available for self-use in Singapore and an empirical observation suggests that the majority of dentifrices are fluoridated. However, some manufacturers have increasingly marketed non-fluoridated toothpastes containing other "substitute" proprietary ingredients such as chlorhexidine, triclosan, and even green tea.

Some South Asian migrants still use traditional cleaning powders or pastes instead of fluoridated toothpastes. This number could possibly increase

Table 1. Uses of fluoride in Singapore

Type of fluoride regime	Name of fluoride vehicle	Current status
Community	Water fluoridation	100% coverage since 1958
	Milk fluoridation	NA
	Salt fluoridation	NA
Professionally applied	Fluoride varnishes	Available
	Fluoride gels	Available
	Silver fluorides/silver diamine fluorides	Not available locally, individual professionals have to order from overseas
Self-use by individuals	Fluoridated toothpastes	Available
	Fluoride mouthrinses	Available
	Fluoride supplements	NA

with the increasing number of immigrants from the Indian subcontinent.

The Health Science Authority (HSA) of Singapore has also set guidelines regarding the maximum concentration of fluoride that can be present in dentifrices that are imported into Singapore. Toothpastes available can be divided into those for children and those for adults based on the content of fluoride concentration.

Currently, the product with the highest concentration of fluoride available "over-the-counter" locally is Colgate's Neutrafluor 220 Daily Fluoride Rinse (0.05% w/w neutral sodium fluoride). Toothpastes with much higher concentrations of fluoride (i.e. 5,000 ppm) are not available; however, there are ongoing discussions with the relevant health authorities to introduce Neutroflor toothpaste (5,000 ppm, marketed by Colgate) into Singapore. Table 1 shows the various forms of fluoride available in Singapore.

Outcomes in Dental Caries Control

In 1957, a baseline study was carried out before the implementation of water fluoridation.[7] The study comprised annual surveys conducted over a 10-year-period to evaluate the effect of water fluoridation on dental caries. Children in the control group were selected from schools in unfluoridated Malacca, West Malaysia. Each year, 2200 Malay and Chinese children aged between 7 and 9 years were selected from Singapore and Malacca.

The results showed a 30.8% decline in primary dentition caries experience among the Singapore children, whereas there was no corresponding decline observed among the Malaccan (control) group.[7] For permanent dentition, the Malaccan Malays experienced a 63.1% increase in caries experience compared with a 31.0% decrease among Singaporean Malays. On the other hand, Malaccan Chinese children showed a 21.6% increase in permanent caries experience compared to their Singaporean peers who experienced a reduction of 52.3%.[7] The greater reduction in caries experience observed among the Chinese was reported to be due to the higher prevalence of dental caries over their Malay counterparts.[7]

Subsequent surveys by various authors have reported steadily declining dental caries experience in school children aged between 6 and 18 years. A composite of these various findings are shown in Table 2. For example, Lo and Bagramian[8] reported that sequential school dental surveys carried out by the Ministry of Health showed an increase in the proportion of children free of caries in the permanent dentition from 30.0% in 1970 to 58.7% in 1994. There was also a decline in mean DMFT from 2.60 to 1.08 for school children aged 6–11 years and the mean DMFT had decreased from 2.98 in 1970, 2.61 in 1979, 1.97 in 1984, 1.61 in 1989 to 1.05 in 1994.[10] In each of these surveys, approximately 5000 school children aged 6–18 years were examined and this sample size represented 1.2% of the school going population.[8] The latest survey carried out by the Health Promotion Board in 2003 on the dental caries prevalence of school children in Singapore found the DMFT for 12-year-olds to be 0.54.[9]

However, the success in caries control among Singaporean school children is not seen in

Table 2. Mean dmft and DMFT scores for various age groups in Singapore by chronology

Age (years)	Year	Mean DMFT	Source*
5 (preschool) (dmft)	2005	2.03	6
6 (dmft)	1970	0.41	4
	1979	0.39	4
	1984	0.15	4
	1989	0.13	4
	1994	0.09	4
6–11 (DMFT)	1970	2.6	10
	1979	2.1	10
	1984	1.9	10
	1989	1.3	10
	1994	1.1	10
12 (DMFT)	1970	2.97	4
	1979	2.84	4
	1984	2.47	4
	1989	1.39	4
	1994	0.98	4
	2003	0.54	5
12–18 (DMFT)	1970	4.6	10
	1979	3.8	10
	1984	3.2	10
	1989	2.5	10
	1994	1.6	10

*Numbers refer to reference citations from the reference list (e.g. 4 refers to Loh, 1996).

pre-schoolers as suggested by a recent examination of 1782 pre-schoolers aged 3–6 years carried out in 2005 by Gao et al.[10] The authors found that about 40% of the study group had dental caries. The mean DMFT (SD) among 3–4, 4–5, and 5–6-year-olds were 0.70 (1.78), 1.40 (2.68), and 2.03 (3.07), respectively. This study also found that 16% of the children carried 78% of the burden of disease and that 16.5% of children suffered from rampant caries (defined in the study as caries affecting smooth surfaces of two or more maxillary incisors).

The authors of the study attributed their findings to the "plateau effect of water fluoridation and insufficient organized dental services and oral health promotion for the pre-schooling population." The authors therefore suggested extending the School Dental Service to pre-schoolers, particularly those at a high-risk of dental caries.[10]

In addition, Gao et al.[10,11] also reported that higher caries experience and unmet treatment needs were found among children of lower socioeconomic status (Social Economic Status proxies used were parental education level and children living in public housing units, HDB apartments) and the indigenous population (Malays). They attributed the racial and socioeconomic difference in caries severity to differences in: (i) poor oral health practices/behaviours (such as prolonged breastfeeding, night time bottle feeding, cariogenic diet); (ii) dental awareness and knowledge of parents and caregivers; (iii) cultural, ethnic and religious norms and beliefs (i.e. how people of different ethnicities prioritize their resources, how attentive and receptive they are to health education messages, and how they synthesize and comprehend these information); and (iv) barriers to assessing oral healthcare services faced particularly by the disadvantaged.

Lessons Learned and Future Challenges

Singapore is fortunate that water fluoridation has been in place for over half a century and there have been no reports of opposition to this public health measure at the onset of its implementation.[4] In recent years, however, opposition to water fluoridation has increased probably due to a better educated and well-travelled populace that has found its political voice and the myriad of anti-fluoridation material that is readily accessible off the internet (water fluoridation hardly receives any media attention in Singapore). It is hoped that the lukewarm or mild opposition to fluoridation would remain the same in time to come as the overall political atmosphere of the populace is fairly muted.

In line with systematic reviews and audits of all governmental policies, the Ministry of Health has set up a fluoride review committee whose objective is to monitor and conduct reviews on the fluoridation of drinking water by: (i) determining the appropriate and safe concentration levels of fluoride to maintain in Singapore's drinking water in order to achieve optimal effectiveness against dental caries; (ii) determining

the estimated daily fluoride exposure per individual; and (iii) debating the need for mandatory fluoridation of the drinking water supply.

It is highly unlikely that water fluoridation would be reversed and the role of the committee is more to review the contemporary literature as is required of good public health practices.

Generally, the levels of oral health in Singapore are good and are comparable to other developed countries. Singapore is fortunate to have enjoyed universal coverage of water fluoridation for over 50 years. The population is also highly educated and health awareness is generally high. The School Dental Service provides 'free' dental care to school children up to 18 years of age. Furthermore, primary dental care is also readily accessible by the general public. Twenty-five percent of primary dental care is provided through public sector community clinics (polyclinics), which are heavily subsidized by the government, whereas the remaining 75% is provided by an extensive network of private general practice clinics found across the island. Moreover, public education to increase awareness and literacy of healthcare issues are also routinely carried out by the Health Promotion Board.

The challenges facing Singapore are:

1. Addressing the inequality of dental caries—a burden that is mainly carried by members of lower socioeconomic groups and the indigenous population.
2. Addressing the high dental caries experience among pre-schoolers.
3. With the government's policy of attracting foreign talent and the resultant rapid influx of immigrants, it is expected that the prevalence of dental caries would increase and there is a need to look into the provision of accessible and affordable dental care and services.
4. Fine tune the current healthcare delivery system to ensure that the less fortunate, elderly, and those with special needs are not deprived of accessing oral healthcare services.
5. More effective inculcation of good dental homecare and dietary habits by the public in view of the popularity of fizzy and sports drinks consumed by many Singaporeans.

Some suggestions that have been advocated by Gao et al.[11] to overcome the racial and socioeconomic inequality in oral health among pre-schoolers are: (i) professionals should provide specific tailor-made advice rather than generic ones with respect to oral health behaviors and seeking dental services; (ii) public literacy programs to advocate increased dental attendance; (iii) addressing barriers to assessing dental services that are faced by disadvantaged communities; and (iv) understanding the health-related values and lifestyles of the different target population in a multi-ethnic society (i.e. the frequent intake of sweet deserts in the Malay community).

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Scientific Article

The Accuracy of Demirjian Method in Dental Age Estimation of Malay Children

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Abstract

This study is aimed to evaluate the accuracy of Demirjian method in estimating the chronological age of male and female Kelantanese Malay children between 6 and 16 years of age and to establish a new dental age (DA) curve if the Demirjian method was not found to be accurate. About 905 panoramic radiographs of healthy Malay children between 6 and 16 years of age were collected from the radiographic unit in the Hospital Universiti Sains Malaysia (HUSM) and the orthodontic clinic in Hospital Kota Bharu (HKB). Children who had any disease affecting the dental development, or have agenesis in the lower arch and poor quality radiographic images were excluded. The results showed that Demirjian method overestimated the chronological age (CA) by 1.23 years for boys and 1.20 years for girls and it was less accurate for the Kelantanese Malay children. Thus new standard curve were produced and tested on external samples. Results showed that the mean difference between the chronological age and DA is about 0.17 years for boys and 0.11 years for girls. DA was more advanced in the Kelantanese Malay boys and girls as compared to French-Canadian children in all age groups. It is concluded that the Demirjian method tends to be less accurate in estimating the chronological age in Malay children. The new curve that was produced is more applicable to the Kelantanese Malay children. [*Singapore Dent J* 2011;32(1):19–27]

Key Words: dental age, growth and development, teeth, Demirjian method, Malay, children

Introduction

Dental age (DA) is of particular interest to the orthodontist in the treatment planning of different types of malocclusions in relation to maxillo-facial growth.[1] DA can be defined either as a measure of how far the teeth have progressed towards maturity[2] or as a measure of childhood dental development,[3] and it corresponds to odontogenesis, development, and emergence of teeth.[4]

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DA can be assessed for deciduous or permanent teeth by determining the chronology of teeth emergence through the oral tissues,[5] by counting the number of emerged teeth into the oral cavity,[6] or by tracing the calcification progress of dental tissues using successive radiographic films (radiographic DA).[7–9] Demirjian et al[1] have proposed the staging of teeth based on the estimation of growing teeth shape instead of the teeth dimensions using lower left seven permanent teeth excluding the third molar.[10]

DA is a good indicator for evaluating the biological age of a growing child since it is less affected by variation in nutritional and endocrine status compared to the other biological age methods,[11–12] and is subjected to less variation in relation to the chronological age than the skeletal age.[13] In interceptive orthodontic, knowing the time of each stage of tooth development may give general ideas

to dental clinicians in proposing proper treatment plans, e.g. the prediction of emergence time of permanent teeth based on root developmental stage can help in planning for serial extraction.[9]

Variations in dental development exist between different ethnics and populations.[14,15] Thus, foreign dental developmental standards and data might not be applicable for the local people. DA based on the time of permanent teeth clinical eruption on Malay population was conducted on more than 2000 school children between 5 and 17 years of age.[5] From our observation, this study showed that the emergence of teeth occurred when the teeth are in the stages (E) and (F) with more closer to stage (F) for both sexes, thus giving us the idea that emergence of the teeth into the oral cavity occurred between a period when root length is half or more than the crown length and when both crown and root have the same length. The only exception is for the first molar where it is found to be before the stage (E), nevertheless, no radiograph was taken in their study.

The DA based on radiographic standard of permanent teeth need to be investigated since there is only one study available in Malaysia[16] with 428 subjects between 7 and 15 years of age and the results showed that the Demirjian method overestimated the age for both sexes but no dental curve was produced for the Malay children.

Therefore, a valid standard of DA in Malay population should be constructed in the aim of developing our own reference chart for Malay population. The objectives of this study were to evaluate the accuracy of Demirjian method (1973) in estimating the chronological age of Kelantanese Malay male and female children between 6 and 16 years of age, and to establish a new DA standard for the Kelantanese Malay population if the Demirjian method is not accurate.

Materials and Methods

This is a cross-sectional study which deals with the orthopantomograms (OPGs) of normal healthy Kelantanese Malay children between 6 and 16 years of age and was conducted from September 2005 until March 2007. The OPGs were obtained from two databases: School of Dental Sciences, HUSM and the Orthodontic Dental Specialist Clinic, HKB.

Prior to conducting the study, ethical approval was obtained from research and ethics committee of Universiti Sains Malaysia (USM: 190.2 [1], USMKK/PPSP®/JK EP (M) FWA REG. NO: 00007718, IRB REG. NO: 00004494). Ethical approval was also obtained from Kelantan State Ministry of Health (Bil 72, PP/KEL 60(16/2)/1).

The record of each subject participating in this study was thoroughly examined in order to collect all information needed (i.e. name, record number, date of birth, date of X-ray was taken, and sex) and to check the medical status of the subject. The information was later recorded in the data sheet.

A total of 938 healthy Kelantanese Malay samples were found in the database available in the School of Dental Sciences, Hospital Universiti Sains Malaysia (HUSM), and orthodontic clinic, Hospital Kota Bharu (HKB), consisting of 616 girls (67%) and 322 boys (33%), between 5 and 16 years of age and 33 cases were excluded (Table 1). Nevertheless, during the process of comparison between the Malay children and the French-Canadian children, subjects aged 5 years were excluded due to small sample size.

Only good quality radiograph, with the presence of all permanent teeth from the lower left and right quadrant teeth, except the 3rd molar that was taken for routine dental examination and before the start of orthodontic treatment were selected. Radiographs with distortion such as overlapping images of the teeth or lacking clarity due to under- or over-exposure, or under or over-development of the film, and incomplete information such as date of birth, or date of exposure of radiograph were excluded. Subjects with any history of chronic disease, illness or syndrome known to significantly affect dental development that were obtained from their medical records were also excluded.

The sample size for this study was calculated using the confidence interval formula $n=(Z^*\sigma/\Delta)^2$ where 'n' is sample size in each group. 'Z' is the two-sided Z value required for the 95% confidence interval (CI) which is equal to 1.96. σ is the standard deviation (SD) from source population which was estimated from sample of previous study, $\sigma=0.78$ years.[14] Δ is the precision assigned as 0.2. Therefore the sample size for each age group calculated using the formula is 58 subjects and the total sample size of 11 age groups

Table 1. Distribution of samples according to age and sex

Age	Male		Female		Total	
	n	%	*n*	%	*n*	%
5–5.9	1	0.3	3	0.4	4	0.4
6–6.9	9	2.9	10	1.7	19	2.1
7–7.9	22	7.2	15	3.7	37	4.1
8–8.9	25	8.2	27	4.5	52	5.7
9–9.9	32	10.5	37	6.2	69	7.6
10–10.9	29	9.5	51	8.5	80	8.8
11–11.9	38	12.5	67	11.1	105	11.6
12–12.9	37	12.2	98	16.3	135	14.9
13–13.9	32	10.5	125	20.8	157	17.3
14–14.9	51	16.8	106	17.6	157	17.3
15–16	28	9.2	62	10.3	90	9.9
Total	304	33.5	601	66.5	905	100

(from 5 to 16 years of age) and for both genders is 1276. With the consideration of 5% non-response (e.g. radiographic distortion, under- or over-exposure), the final sample size required is (1,276 + 64) = 1,340 subjects. Nevertheless, only 938 radiographs were retrieved from both databases (HUSM and HKB).

The DA was assessed using Demirjian method with the sex specific tables and the data for DA comparison for the French-Canadian maturity scores were also adapted from the Demirjian et al.'s.[10] Each radiograph has been placed on a radiograph view box and correctly oriented. The same X-ray view box was used to evaluate all radiographs from both sources (HUSM and HKB) to ensure uniformity of the procedures that will be applied on all the radiographs. All OPGs were examined by one examiner. The mandibular left quadrant was analyzed and each tooth in the quadrant except the 3rd molar was examined. Once the stage that most accurately described the state of development of the tooth in question was identified, the rating was assigned to that tooth and recorded in the appropriate box on the data sheet. The examiner was blinded with regards to the chronological age and other details such as the name and gender of the subject when evaluating the radiograph. The process was repeated for each tooth from the lower left quadrant except the 3rd molar. The assigned ratings for each of the seven teeth were recorded on the data sheet for that specific OPG.

"Chronological age" (CA) is the real age of the Kelantanese Malay samples and was obtained by subtraction of the date of the radiograph from the date of birth and the resultant age was converted into decimal age after the radiograph was assessed for Demirjian method. The stages 0 to H, as assessed and recorded for each tooth in each subject in the entire sample, were converted to a numerical score (weighted scores). This was done using the sex specific tables (Tables 2 and 3) constructed by Demirjian et al.[10] and the 7-teeth scores were summed together in order to obtain the maturity score for each case.

An external sample of 47 Kelantanese Malay children (23 boys and 24 girls) aged between 5 and 16 years from HUSM was randomly selected in order to test the accuracy of the new DA standard on Kelantanese Malay population. These external samples were patients in HUSM who came for routine dental check-up and had their OPG taken and they are not involved in the making of the Malay standard curve.

Statistical analyses

The DAs from all samples were analyzed using the Statistical Package for Social Science (SPSS) version 13.0 for Windows. Paired *t*-test comparing the 'chronological age' and the 'dental age' was used to examine the accuracy of Demirjian method in estimating the CA of male and female Kelantanese Malay children between 5 and 16 years of age. In order to establish a new DA

Table 2. Self weighted scores for dental stages (7 teeth) – Boys (Ref. No. 10)

Boys	0	A	B	C	D	E	F	G	H
M 2	0.0	1.7	3.1	5.4	8.6	11.4	12.4	12.8	13.6
M 1	–	–	–	0.0	5.3	7.5	10.3	13.9	16.8
PM 2	0.0	1.5	2.7	5.2	8.0	10.8	12.0	12.5	13.2
PM 1	–	0.0	4.0	6.3	9.4	13.2	14.9	15.5	16.1
C	–	–	–	0.0	4.0	7.8	10.1	11.4	12.0
I 2	–	–	–	0.0	2.8	5.4	7.7	10.5	13.2
I 1	–	–	–	0.0	4.3	6.3	8.2	11.2	15.1

Table 3. Self weighted scores for dental stages (7 teeth) – Girls (Ref. No. 10)

Girls	0	A	B	C	D	E	F	G	H
M 2	0.0	1.8	3.1	5.4	9.0	11.7	12.8	13.2	13.8
M 1	–	–	–	0.0	3.5	5.6	8.4	12.5	15.4
PM 2	0.0	1.7	2.9	5.4	8.6	11.1	12.3	12.8	13.3
PM 1	–	0.0	3.1	5.2	8.8	12.6	14.3	14.9	15.5
C	–	–	–	0.0	3.7	7.3	10.0	11.8	12.5
I 2	–	–	–	0.0	2.8	5.3	8.1	11.2	13.8
I 1	–	–	–	0.0	4.4	6.3	8.5	12.0	15.8

standard for the Kelantanese Malay population, the modified 7-teeth method was carried out by using logistic regression analysis. The 'chronological age' has been regressed against the 'maturity scores' in order to modify the French-Canadian DA conversion tables into Kelantanese Malay one.

The maturity score curves of Kelantanese Malay and French-Canadian have been superimposed upon each other and were compared descriptively.

Table 4. Interpretation of strength of agreement for the kappa statistic (Ref. No. 17)

Value for kappa	Strength of agreement
<20	Poor
0.21–0.40	Fair
0.41–0.60	Moderate
0.61–0.80	Good
0.81–1.0	Very good

Reproducibility of the measurements

Intra-examiner reproducibility for 'maturity scores' and 'dental age' have been assessed. A total of 40 OPGs have been assessed twice with one week interval between the first and the second assessments. The Cohen's kappa value and the intra-class correlation (ICC) have been calculated. The results for the reproducibility in assessment of the maturity scores and DA showed that the intra-examiner correlation was high (0.98) and the reproducibility in assigning the stages showed that the overall values for intra-examiner was 0.65. The kappa values were interpreted using Altman (Table 4).[17] The results showed that there was a "good" agreement for assigning the stages of each assessed tooth for the intra-examiner reproducibility based on Altman.[17] The examiner did not use the Demirjian Dental Development CD-Rom but the examiner had undergone training period and checked the inter-examiner variability and correlation with MFK who is an expert in using the Demirjian method (the inter-examiner correlation was 0.97 and overall value for inter-examiner variability was 0.62). The CD-Rom was not used for comparison of age since it can be done by comparing the chronological age and estimated age based on Demirjian's table.[10]

Table 5. Difference between chronological age and dental age (years) for all subjects

Sex	*n*	CA Mean (SD)	DA Mean (SD)	Mean of age difference (95% CI)	*t* statistic (*df*)[a]	*p* value[a]
Boys	304	11.68 (2.61)	12.92 (3.22)	–1.24 (–1.39, –1.09)	–16.20 (303)	<0.001
Girls	601	12.47 (2.24)	13.74 (2.55)	–1.27 (–1.37, –1.16)	–24.27 (600)	0.001

[a]Paired *t*-test; CA = chronological age; DA = dental age; *df* = degree of freedom; SD = standard deviation.

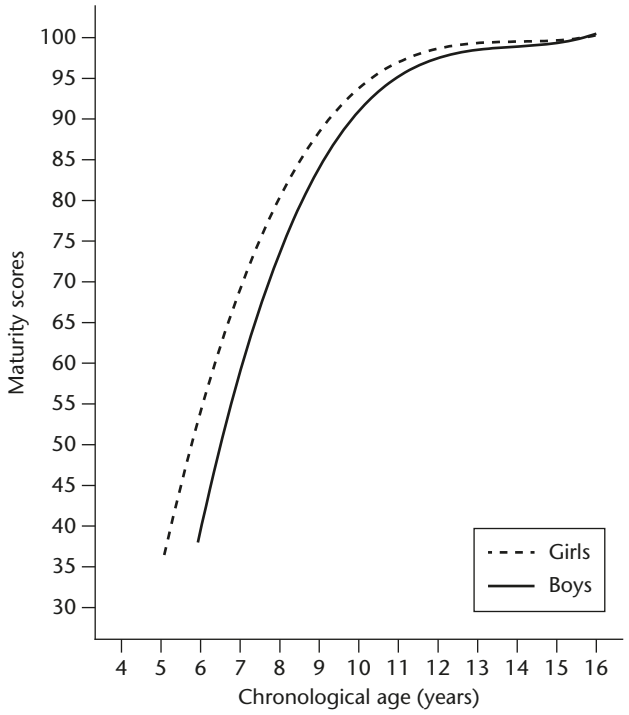

Figure 1. *Comparison of dental age curve for both sexes in Kelantanese Malay children.*

Results

The accuracy of Demirjian method

Demirjian method was not accurate in estimating the chronological age of male and female Kelantanese Malay children between 6 and 16 years of age. The results showed that the mean age differences are statistically significant for both gender (Table 5). The method overestimates the chronological age by an average of 1.23 years for boys and 1.20 years for girls. New DA curves for Kelantanese Malay boys and girls (Figure 1) have been constructed using non-linear regression model (logistic model, SPSS® Base 13.0 User's Guide). The results showed that constants for the logistic model ($Y = 1/[1/100 + (b_0 * b_1^t)]$) for the new curves are ($b_0 = 0.528$ and $b_1 = 0.506$, for boys) and ($b_0 = 1.019$ and $b_1 = 0.501$, for girls). For testing the accuracy of the new curves for estimating the chronological age, external samples of 47 children (23 boys and 24 girls) have been assessed, and the results showed that the mean difference between the chronological age and DA is about 0.17 years for boys and 0.11 years for girls (Table 6 and Figure 2).

The comparison between the DA of Demirjian method for Malay children with French-Canadian ones showed an advanced maturation of Malay children in all ages as compared with their peers of French-Canadian origin (Figures 3 and 4). The results showed that the DA for younger age groups of boys (7.0–9.99 years) was not significantly different from the French-Canadian boys. However, after the 10 years of age, the difference became statistically significant in boys (Table 7). On the other hand, girls were more advanced in DA as compared to French-Canadian girls in all age groups as the difference was statistically significant (Table 8).

Discussion

The majority of the citizens in Kelantan state are of Malay origin (95%), and 90% of them live in rural areas as farmers and fishermen.[5] In this study, the socio-economic status has not been assessed since it was shown that dental development have low tendency to be affected by the socioeconomic status.[12,18] The socioeconomic status is known to have a definite effect on general body growth, but to a lesser extent for the permanent teeth emergence.[19]

It was proposed to include all ages which represent the development of permanent teeth (0–20 years); however, based on the records available in the database, radiographs were taken only for children above 5 years of age because it is difficult to manage children below 5 years and to

Table 6. Difference between chronological age and dental age (years) for the external samples

Sex	*n*	CA Mean (SD)	DA Mean (SD)	Mean of age difference (95% CI)	*t* statistic (*df*)[a]	*p* value[a]
Boys	23	10.85 (3.37)	10.69 (3.4)	0.17 (–0.16, 0.5)	–1.03 (22)	0.314
Girls	24	10.02 (2.88)	9.92 (3.57)	0.11 (–0.32, 0.53)	–0.51 (23)	0.611

[a]Paired *t*-test; CA = chronological age; DA = dental age; *df* = degree of freedom; SD = standard deviation.

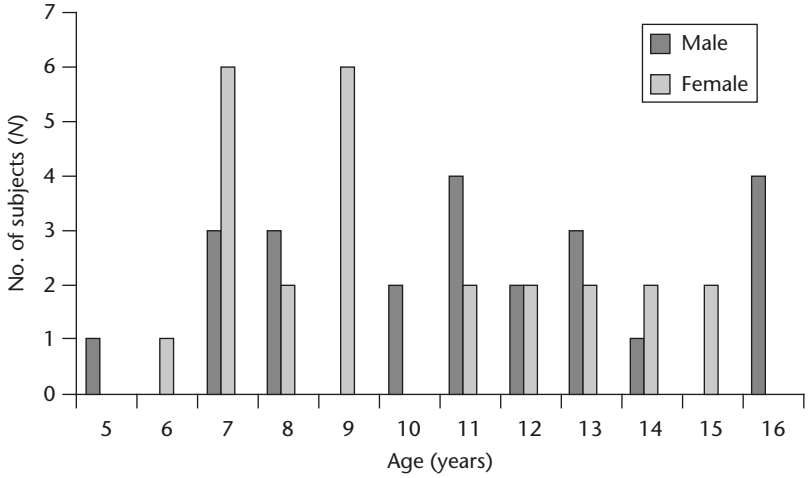

Figure 2. *Bar chart showing the number of external samples based on their age group.*

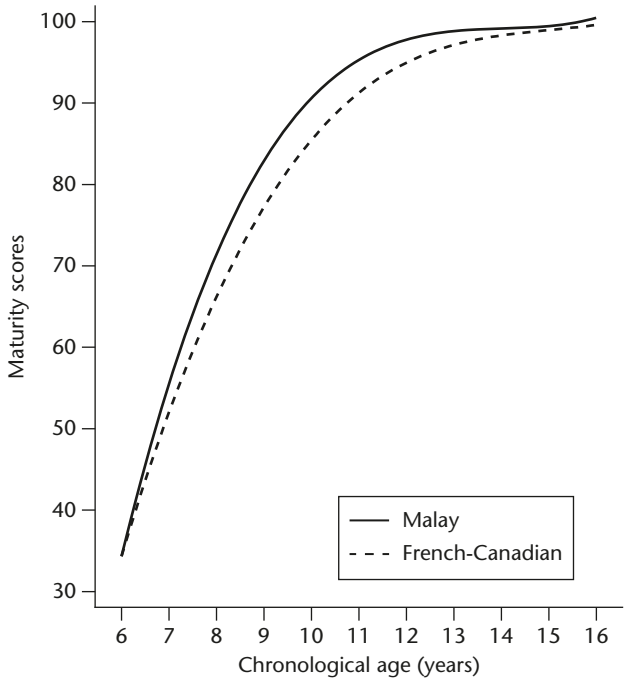

Figure 3. *Comparison of maturity score curves between Malay and French-Canadian boys.*

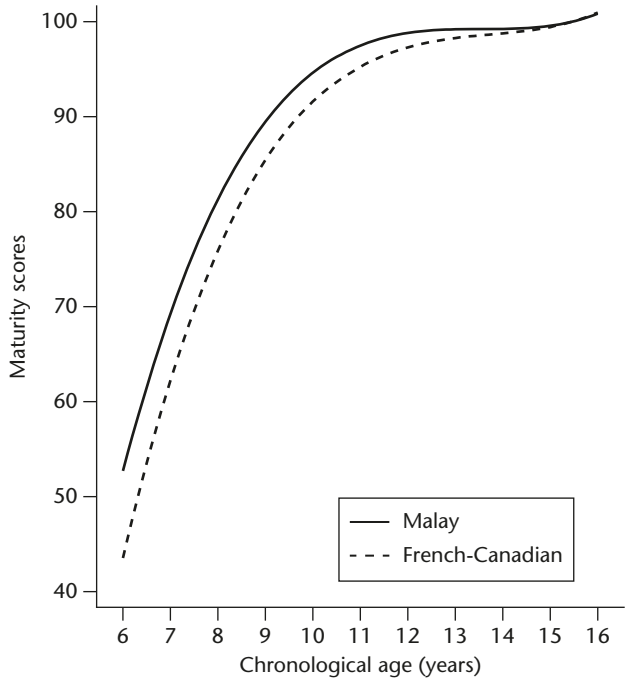

Figure 4. *Comparison of maturity score curves between Malay and French-Canadian girls.*

obtain a good quality OPGs. Based on the databases available, it did not have periapical films which can be used instead of OPG radiographs. Since the number of children between 5 and 5.99 years of age was very small, it was excluded from the comparison of DA with the French Canadian children. The age range for the study was changed to fall between 6 and 16 years.

Table 7. Difference between chronological age and dental age (years) for boys

Age	*n*	CA Mean (SD)	DA Mean (SD)	Mean of ages difference (95% CI)	*t* statistic[a] (df)	*p* value[a]
6–6.99	9	6.45 (0.26)	7.18 (0.51)	–0.73 (–1.05, –0.40)	–5.17 (8)	<0.001
7–7.99	22	7.45 (0.33)	7.56 (0.34)	–0.11 (–0.26, 0.04)	–1.51 (21)	0.146
8–8.99	25	8.44 (0.32)	8.65 (1.05)	–0.21 (–0.61, 0.20)	–1.06 (24)	0.300
9–9.99	32	9.52 (0.31)	9.82 (1.62)	–0.31 (–0.85, 0.24)	–1.15 (31)	0.260
10–10.99	29	10.56 (0.26)	12.13 (1.19)	–1.58 (–2.02, –1.13)	–7.29 (28)	<0.001
11–11.99	38	11.49 (0.29)	13.72 (1.42)	–2.23 (–2.67, –1.80)	–10.35 (37)	<0.001
12–12.99	37	12.51 (0.29)	14.71 (1.44)	–2.20 (–2.56, –1.75)	–9.81 (36)	<0.001
13–13.99	32	13.50 (0.31)	15.58 (0.83)	–2.08 (–2.39, –1.79)	–14.41 (31)	<0.001
14–14.99	51	14.44 (0.26)	15.80 (0.46)	–1.36 (–1.52, –1.21)	–17.70 (50)	<0.001
15–15.99	28	15.46 (0.30)	15.94 (0.17)	–0.49 (–0.62, –0.35)	–7.36 (26)	<0.001

[a]Paired *t*-test; CA = chronological age; DA = dental age; *df* = degree of freedom; SD = standard deviation.

Table 8. Difference between chronological age and dental age (years) for girls

Age	*n*	CA Mean (SD)	DA Mean (SD)	Mean of ages difference (95% CI)	*t* statistic[a] (df)	*p* value[a]
6–6.99	10	6.50 (0.35)	7.01 (0.77)	–0.51 (–0.95, –0.76)	–2.66 (9)	<0.05
7–7.99	15	7.62 (0.32)	7.98 (0.59)	–0.37 (–0.65, –0.08)	–2.71 (14)	0.017
8–8.99	27	8.52 (0.30)	9.28 (1.88)	–0.77 (–1.50, –0.03)	–2.15 (26)	0.041
9–9.99	37	9.53 (0.26)	10.69 (1.74)	–1.16 (–1.71, –0.61)	–4.28 (36)	<0.001
10–10.99	51	10.53 (0.27)	11.91 (1.51)	–1.38 (–1.80, –0.95)	–6.50 (50)	<0.001
11–11.99	67	11.51 (0.29)	13.01 (1.68)	–1.50 (–1.89, –1.10)	–7.60 (66)	<0.001
12–12.99	98	12.55 (0.31)	14.52 (1.34)	–1.97 (–2.24, –1.70)	–14.57 (97)	<0.001
13–13.99	125	13.49 (0.29)	15.06 (0.88)	–1.57 (–1.73, –1.41)	–19.44 (124)	<0.001
14–14.99	106	14.52 (0.28)	15.46 (0.78)	–0.94 (–1.09, –0.78)	–12.11 (105)	<0.001
15–15.99	62	15.38 (0.26)	15.82 (0.40)	–0.44 (–0.57, –0.32)	–7.11 (57)	<0.001

[a]Paired *t*-test; CA = chronological age; DA = dental age; *df* = degree of freedom; SD = standard deviation.

DA method should have high value for reproducibility. Reproducibility of the method refers to the reliability (precision) of a measurement which is the degree to which further measurements of the same method show same or similar results.[20] This study has shown that Demirjian method has good reproducibility and it is concurrent with the other study.[16,21–23]

Variations in the determination of DA exist between different ethnics and populations.[14,15] Thus, any foreign DA standard should be tested over the local population in order to assess its accuracy. Demirjian method overestimated the chronological age among the Malay boys and girls which indicates that the method is less accurate when applied on Kelantanese Malay children. In this study, the modified DA curve for Kelantanese Malay children based on the Demirjian method has been produced and tested over external samples and it was shown to be more accurate and can be used as a baseline to determine DA in the Kelantanese Malay children. However, the external samples that were used to assess the accuracy were few. Thus, a bigger and larger number of subjects are needed for future studies. The difference in DA between populations might be attributed to different genetic background since the environmental variations was shown to have less effect on dental development.[25]

The DA of Kelantanese Malay children was expressed using non-linear regression model (logistic regression) (SPSS® Base 13.0 User's Guide) and it was shown that it was not related to that of

the French-Canadian population investigated by Demirjian.[19] In the present investigation, the logistic regressions (SPSS® Base 13.0 User's Guide) were approximated to the calculated data in order to describe the relation between the sum score and the chronologic age for girls and boys and to facilitate the estimation of DA. Frucht et al.[14] used logistic function to describe the relation between the sum score and the chronologic age for their samples while Nystrom et al.[26] grouped their Finnish children into 6-month chronological intervals, drew a diagram of the mean values and smoothed the resulting curves by hand. Nevertheless, these methods all produced the designated DA curve for the population under study.

One of the advantages of the Demirjian method is that it allows for the comparison of the dental development between different populations. In this study the comparison was made between Kelantanese Malay and French-Canadian children and the mean DA difference between the two populations was small for the younger age groups. This situation can be explained owing to the growth prediction uncertainties in younger age group children.[27] However, in the older age groups, marked differences were noticed for both sexes. The difference in DA in older age groups explained as stages occurring earlier in life are generally of shorter duration than the stages occurring later, so short duration stages are more informative than those of long duration. The small differences in younger age groups can probably be explained by relatively high number of stages (A–D) with short duration in young children.[28] The marked difference in older age group can be explained on a basis of prepubertal or pubertal growth changes during these age groups. Another explanation that DA distribution which does not exhibit a Gaussian distribution (there is tendency to be skewed) after a certain chronological age, which in turn results in a distortion of the results, leading to systemic overestimation of age when chronological age is estimated from dental development.[28] In addition, it is also may be due to positive secular trend in growth and development during the last 25 years.[21,22] A smaller mean difference can be seen in the oldest age group. This might be attributed to increasing impact of maturity scores in older ages.[28]

One disadvantage of the Demirjian method[1] is the need to assess seven teeth, as aplasia of both lower second premolars is not an uncommon finding. The databases from longitudinal studies appear to be more accurate than those of cross-sectional investigations as it gives a sufficient access to the individual dynamics of growth.[29] However, because of the extensive time involved and especially as the level of radiation exposure is high, such studies are not permitted by the Malaysian legislation and they are rarely feasible. Demirjian and Lévesque[29] assessed the DA of 722 French-Canadian children and about 3,800 radiographs were obtained from longitudinal and cross-sectional data. The results showed no significant differences between the longitudinal and cross-sectional data for the seven teeth of both sexes.

At the time where the study was conducted, most subjects were undergoing orthodontic treatment and this may have caused for the non-random sample selection which might not represent the general population.[14] The distribution of the samples in this study was more toward girls, it seems that there is more predilection for girls to visit the dental clinics especially the orthodontic clinic more than the boys do, and girls always show more concern about improving their beauty and they visit the orthodontic clinics to achieve the perfectly straight teeth which enhances their beauty.[30–32]

Conclusion

The Demirjian method is not accurate to estimate the chronological age in the Kelantanese Malay children. The methods overestimated the chronological age which indicates that the method is less accurate when applied on Kelantanese Malay children. Thus, a new DA standard was developed for the local population studied and is more applicable to the Kelantanese Malay children. DA was more advanced in Kelantanese Malay boys and girls as compared to French-Canadian children in all age groups.

Acknowledgement

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Case Report

Prosthodontic Management of an Edentulous Patient With an Acquired Maxillary Defect Reconstructed With an Abdominus Free Flap: A Clinical Report

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Abstract

Functional rehabilitation of fully edentulous maxillary defects is always regarded as a prosthodontic challenge. Surgical augmentation does not always offer value addition in the functional treatment outcome. This article describes the maxillofacial prosthodontic treatment of an edentulous patient who received an abdominus microvascular free flap surgical augmentation of a large acquired maxillary defect. [*Singapore Dent J* 2011;32(1):28–32]

Key Words: free flap surgery, edentulous, prosthodontic challenge

Introduction

Edentulous patients with acquired maxillary defects are always a prosthodontic challenge.[1,2] Endosseous implants enhance retention of the obturator prosthesis but the additional cost is commonly one of the reasons to preclude the prescription of endossoeus implants.[3,4]

Prosthodontic prognosis is affected by the postsurgical bony anatomy, availability of abutment teeth, size of the defect, quality of mucosa, history of radiation therapy, the patient's experience with dental prostheses, and the neuromuscular control of the patient.

The overall treatment outcome is dependent on a thorough understanding of surgical and prosthodontic limitations and a close collaboration between the surgical and prosthodontic clinicians.

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A successful prosthodontic rehabilitation should restore facial contour, improve mastication, improve speech intelligibility, provide lip support, and improve articulation.[4]

Reconstruction of mandibular defects with microvascular free flaps has been rather successful, which has encouraged their use in the reconstruction of maxillectomy defects.[5] Microvascular reconstruction may enhance treatment outcomes providing that the surgery improves the quality of the tissue bed from a functional rehabilitation standpoint.[6]

Surgical reconstruction of maxillary defects has been attempted by many clinicians.[7] Surgical reconstruction of acquired maxillary defects reduces speech and swallowing problems that are commonly associated with maxillectomy defects. One main benefit of this procedure is probably in the psychological benefit of the perceived defect size reduction to the patient.[8]

Free flap reconstruction of maxillectomy defects effectively recreates the partition between the oral and sinonasal cavities.[6,7,9–11] Microvascular free flap reconstruction of maxillectomy defects is sometimes indicated as a better clinical strategy than prosthodontic rehabilitation.[9,10–12]

Medical literature has described favorable outcomes for surgical reconstruction of maxillary defects.[9–12] However, the clinical challenges in subsequent prosthetic rehabilitation is seldom mentioned.[5,8] The quality of treatment outcomes for patients with maxillary defects that have been rehabilitated with microvascular free-flap surgery and conventional maxillofacial prosthetics has not been demonstrated sufficiently through clinical research.[5] The clinical outcome of such reconstruction may not necessarily improve the subsequent prosthodontic rehabilitation.[4,5]

Maxillary obturator prostheses in edentulous patients have stability limitations and exhibit some movements regardless of the soft tissue reconstruction.[8] It is known that most patients with acquired intra-oral defects prefer to masticate using the untreated side.[13]

After acquired defects are surgically reconstructed, maxillofacial prosthetic treatment is commonly indicated for the rehabilitation of normal oral function in most maxillectomy patients.[6,14] Even though surgical reconstruction might eliminate the surgical defect, the subsequent prosthesis is still being considered as an obturator prosthesis.[5]

The soft tissue covering the normal hard palate varies significantly in consistency and thickness among different anatomical locations.[15] The relatively mobile tissues should be impressed in a resting condition so that the completed denture base would not be unseated.[16–18] It is suggested that an escape hole 1.0 mm or larger, or a spacer with the thickness of a sheet of base plate wax, may be used to selectively reduce palatal impression pressure when making an impression of an edentulous maxilla.[18]

This clinical report describes the prosthetic management of a patient who received an abdominus microvascular free flap reconstruction of a right maxillectomy defect.

Clinical Report

A 67-year-old man was referred to Specialist Dental Group at the Mount Elizabeth Hospital, Singapore by his head and neck surgeon for prosthodontic rehabilitation evaluation. The patient and his family live in Vietnam.

He had a history of squamous cell carcinoma of the right maxillary sinus and had undergone a right maxillectomy six months prior to the prosthodontic consultation. Following the ablative tumor surgery, the defect was reconstructed with an abdominus free flap for the replacement of soft tissue. He was not sent for pre-surgical prosthodontic assessment and no dental prosthesis had been prescribed since the ablative tumor surgery.

No attempt was made to replace the missing maxillary osseous structure (Figure 1). He was treated post-operatively with external-beam radiation therapy to a total dose of 6600 cGy and concurrent chemotherapy.

A clinical examination revealed that the right maxillary alveolus, palate and buccal vestibule were missing (Figure 2). The surgically reconstructed

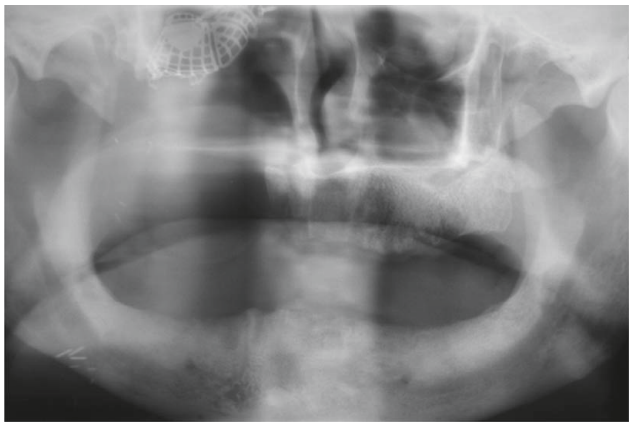

Figure 1. *Panoramic radiograph showing the maxillary defect. A titanium mesh was place at the inferior border of the right orbit to support the orbital content. No signs of bony reconstruction was noted on the right maxillary defect.*

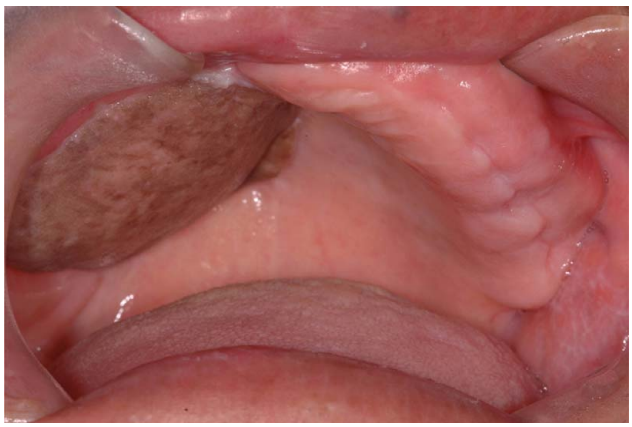

Figure 2. *Clinical view of the surgically reconstructed maxillary defect.*

defect was flabby under gentle bimanual palpation (Figure 3). It was estimated that the magnitude of superior-inferior displacement of the tissue bed was approximately 10 mm under digital pressure at the maxillary right first molar area. The quality of the tissue bed was unfavorable for predictable prosthetic rehabilitation.

The patient was concerned about his reduced lower facial height as he had reduced vertical dimension of occlusion and inadequate lip support. Speech and swallowing were within normal limits otherwise.

Due to financial constraints, additional surgical augmentation or placement of dental implants were ruled out in his rehabilitation. A definitive conventional obturator and a mandibular removable complete denture prosthesis were planned.

Treatment Sequence

Maxillary and mandibular diagnostic impressions were made using irreversible hydrocolloid (Orthoprint, Zhermack, Italy). The diagnostic casts were poured in Type V dental stone (Noritake Dental Stone, Kyoto, Japan) (Figure 4). Custom impression trays were made using auto-polymerized acrylic resin (Tray Resin II, Shofu, Kyoto, Japan).

The intaglio surface of the maxillary custom tray over the right maxillary area was relieved with one layer of wax (NeoWax; Dentsply Intl) and two 1.5 mm escape holes to ensure no excessive tissue pressure was exerted over the free flap during impression making. In order to minimise distortion over the free-flap, border-molding was only performed on the un-resected side. The maxillary and mandibular custom trays were border molded using fast-setting heavy bodied vinyl polysiloxane material (Imprint 3, Quick Step, 3M Espe AG, Germany) (Figure 5). Upon polymerization, the border-molded impression trays were withdrawn and inspected for accuracy.

Tray adhesive (Tray adhesive; Dentsply Intl) was applied to the intaglio surface and borders of the impression trays. Definitive impressions for fabrication of the prostheses were made with regular-bodied vinyl polysiloxane impression material (Imprint 3 regular Body, 3M Espe AG, Germany) (Figure 6). The definitive casts were poured in type

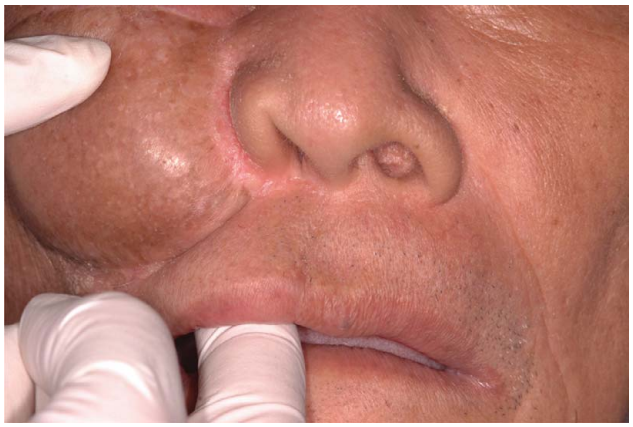

Figure 3. *Under gentle bimanual digital palpation, it was estimated that the tissue flap was move-able approximately 1 cm superio-inferiorly.*

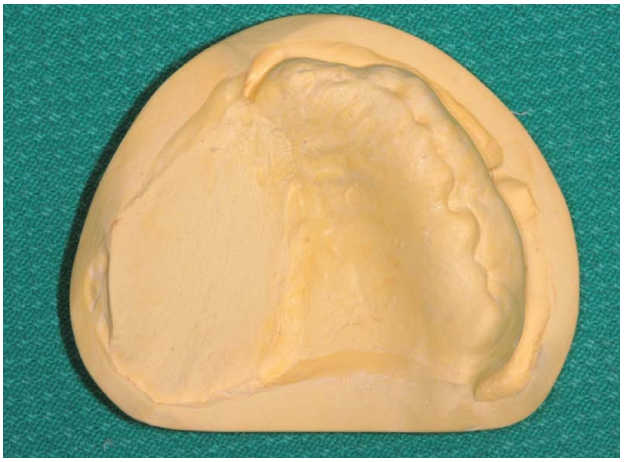

Figure 4. *Diagnostic dental stone cast of the surgically reconstructed maxillary defect.*

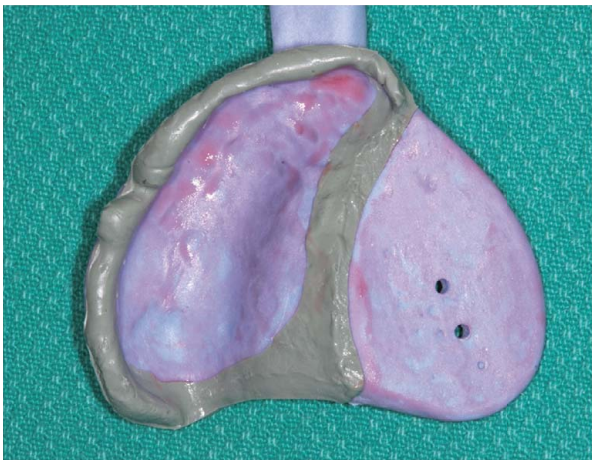

Figure 5. *Maxillary custom tray after border molding. Only the un-resected side was border-molded. The reconstructed area was relieved and pressure relieve holes were made.*

V dental stone (Noritake Dental Stone, Kyoto, Japan).

A centric relation record was made with record bases (Tray Resin II, Shofu, Kyoto, Japan) and wax occlusion rims (NeoWax; Dentsply Intl) using an interocclusal registration material (Regisil; Dentsply Intl). The occlusal vertical dimension was recorded at a reduced dimension to ensure sufficient interocclusal space to ease food bolus manipulation. The casts were mounted in a semi-adjustable articulator with a facebow record (Hanau Wide-vue; Teledyne Waterpik, Fort Collins, Colo) and the centric relation record. A monoplane occlusal scheme was prescribed to minimise lateral forces on the maxillary prosthesis. Zero-degree artificial teeth (Dentacryl SA; Dentsply Intl) were arranged. The excessive tissue bulk of the free flap in the maxilla required the placement of the maxillary right posterior denture teeth in a cross bite position.

After the denture teeth set-up was clinically approved by the patient and his family, the denture prostheses were processed using heat-polymerized acrylic resin (Lucitone 199; Dentsply Intl) (Figure 7). At the insertion appointment, denture base adjustments were performed with a pressure indicating paste (Pressure Indicating Paste; Mizzy Inc, Cherry Hill, NJ) (Figure 8). The patient was instructed in the insertion and removal of the prostheses.

The inherent mobility of the free flap and absence of the right maxillary osseous structures did not offer adequate retention and support of the maxillary prosthesis. Thus the use of denture adhesive was required. The patient was instructed to limit his masticatory function to his unresected side only.

The patient and his family were pleased with the esthetic outcome of the prosthetic treatment. Daily oral hygiene instruction was reinforced. After the initial period of post-insertion adjustment, follow-up appointments were scheduled every 6 months.

Discussion

In this report the patient had an acceptable facial appearance but limited oral function after the ablative tumor surgery and surgical reconstruction. The surgical reconstruction successfully recreated a partition between the nasopharynx and the oral cavity but the resulting tissue bed did not allow for the development of proper denture border seal or prosthetic extension superiorly into

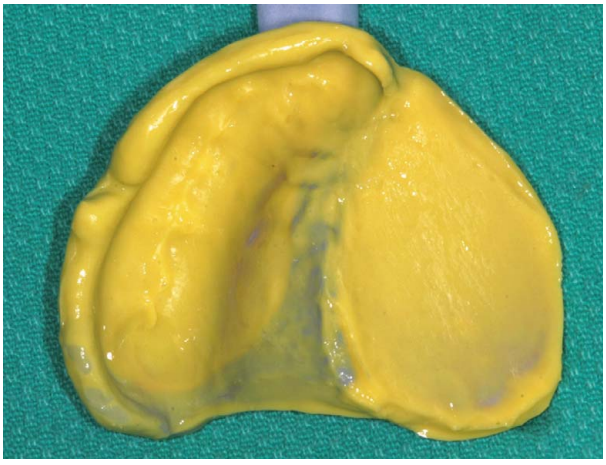

Figure 6. *The completed definitive maxillary impression.*

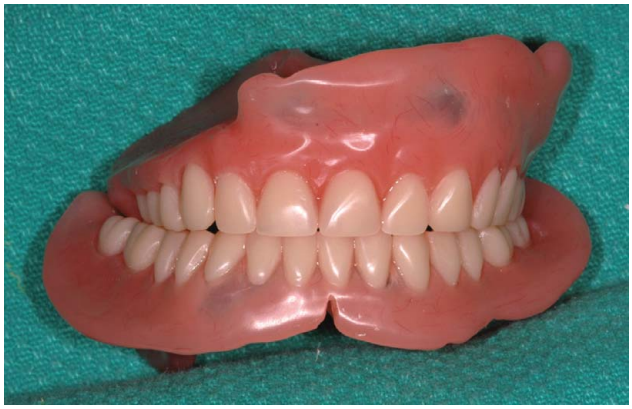

Figure 7. *Frontal view of the maxillary and mandibular prostheses.*

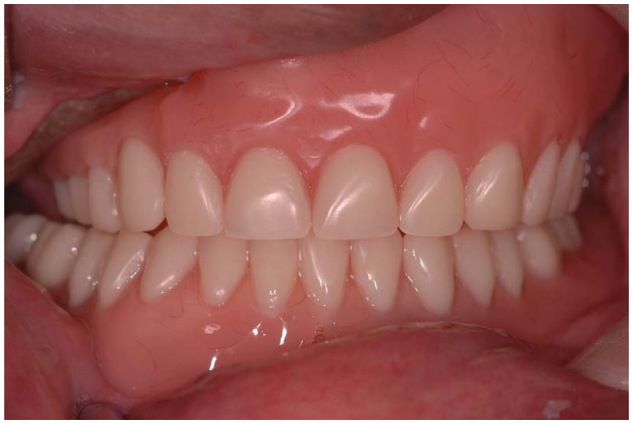

Figure 8. *Maxillary and mandibular prostheses in situ.*

the bone defect to augment support and retention of the prosthesis. From a prosthodontic standpoint, the quality of the maxillary tissue bed was negatively affected by the surgical reconstruction of the maxillary defect.

Currently, it is unclear if conventional prosthetic rehabilitation treatment outcome in a surgically repaired maxillary defect would be superior to the unreconstructed defect.

Summary

This report described the prosthetic rehabilitation of a patient after free flap reconstruction of a maxillectomy defect. Further studies are needed to determine the impact of surgical reconstructive procedures on the functional outcome of the subsequent prosthodontic rehabilitation.

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Case Report

Maxillofacial Prosthetic Management of an Auricular Defect for a Young Patient With Hemifacial Microsomia: A Clinical Report

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Abstract

Facial anomalies in hemifacial microsomia patients may have significant psychosocial impact even from a very young age. The management and fabrication of an auricular prosthesis replacement supported by endosseous craniofacial implants for a young patient with Goldenhar-Gorlin Syndrome has been reported. It is beneficial for the defects of a hemifacial microsomia patient to be managed as early as possible, consistent with the patient's ability to manage the prosthesis. [*Singapore Dent J* 2011;32(1):33–38]

Key Words: craniofacial anomalies, hemifacial microsomia, Goldenhar-Gorlin syndrome

Introduction

Goldenhar-Gorlin Syndrome is a variant of the developmental disorder which falls under the umbrella of syndromes associated with the Oculo-Auriculo-Vertebral Spectrum (OAVS). It is associated with unilateral deformities embrylogically related to the first and second brachial arch derivatives.[1] An incidence of 1 in 5600 live births was proposed by Gorlin to be the most accurate prediction of its frequency.[1] It is estimated to be the fourth most common craniofacial anomaly after cleft lip with or without cleft palate, cleft palate and craniosynostosis.[2]

OAVS is characterized by associated hemifacial microsomia, epibulbar dermoids, auricular appendages, blind-ended auricular fistulars, vertebral anomalies[3] and hypodontia on the affected side of the head.[4] These characteristics are often present in different combinations, and also varying degrees of severity along the spectrum. Auricular defects often with hearing loss, followed by unilateral facial and ocular deformities with right sided predilection, was found to be the most consistent findings among patients with OAVS.[1]

Various genetic[5] and environmental factors such as assisted fertilization,[6] paternal service in the Gulf Wars,[7] maternal smoking and drug use,[8] and diabetic status[9] have been suggested as potential pathogenic mechanisms contributing towards fetal development of OAVS. It is highly likely that the aetiology of this developmental disorder is multi-factorial in nature.

Clinical Report

A 7-year-old healthy Chinese male diagnosed with Goldenhar-Gorlin syndrome was referred to the Graduate Prosthodontic clinic from the Otorhinolaryngology (ENT) clinic for prosthetic assessment and management at the National University Hospital, Singapore (Figure 1). The patient presented with complete aplasia of the right external

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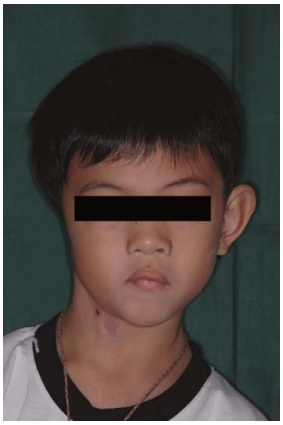

Figure 1. *Seven-year-old patient with Goldenhar–Gorlin syndrome, complete aplasia of right ear.*

Figure 2. *Fitting of surgical template for two craniofacial implants.*

auditory meatus and conduction deafness associated with middle ear abnormalities. It was the parents' main concern to replace the missing right ear for the psychological well-being of the patient.

Clinical and radiographic evaluations were carried out. Preliminary clinical examination showed that the patient presented with gross facial asymmetry with reduced vertical facial proportion on the right side of the face in comparison to the contralateral side. Surgical and prosthetic replacement options were discussed with the parents during a multidisciplinary clinic. The treatment aim was to attempt concurrent replacement of the missing right ear and restoration of hearing function. An implant-retained prosthesis was planned.

Treatment Sequence

Two craniofacial implants (3.75 × 3.0 mm; Entific Medical System, Göteborg, Sweden) were placed in the right temporal bone (posterior and superior to the auricular canal) by the ENT surgeon under a General Anaesthesia. A surgical template was utilized to aid in the placement of the implants[10] (Figure 2).

One craniofacial implant was placed in the right mastoid process to receive a Bone Anchored Hearing Aid (BAHA; Entific Medical System).

At second stage surgery, the implants placed in the temporal bone were exposed. The tissue overlying the implants was thinned surgically down to approximately 2 and 4 mm healing abutments (Standard abutment; Entific Medical System) were inserted. The subcutaneous tissue around the BAHA implant was also surgically thinned and skin-grafted.

After 6 weeks of soft-tissue healing, the patient was reviewed in the Graduate Prosthodontic clinic and an impression was made for the two anterior implants on the right temporal area using vinyl polysiloxane material (Aquasil Ultra LV; Dentsply Caulk, Milford, Del) to fabricate the implant retained auricular prosthesis (Figure 3A).

The impression was poured in type IV stone (Silky Rock; Whip Mix Corp, Louisville, Ky) (Figure 3B) and wax sculpting (Modeling wax; Dentsply, Konstanz, Germany) of the right ear was developed according to the contralateral ear. The wax sculpting was tried on clinically for esthetic assessment (Figure 4A–4C).

The sculpting was invested and the wax was boiled out before separating the cope and drag of the flask.

The tissue bar was designed on the master cast by visually checking with the cope to ensure sufficient space for acrylic resin housing and the silicone prosthetic material.

The tissue bar framework was established using gold cylinders (4 mm; Entific Medical System) and round plastic bar (Plastic bar; BIOMET 3i, West Palm Beach, FL, USA) and casted in noble alloy (Bond on-4; Degussa, Hanau, Germany). The framework was tried in clinically, sectioned and soldered to achieve passive fit over the implants (Figure 5).

The tissue bar was returned to the definitive cast and four metal clip attachments (Clip attachment 2 mm; Entific Medical System) were placed

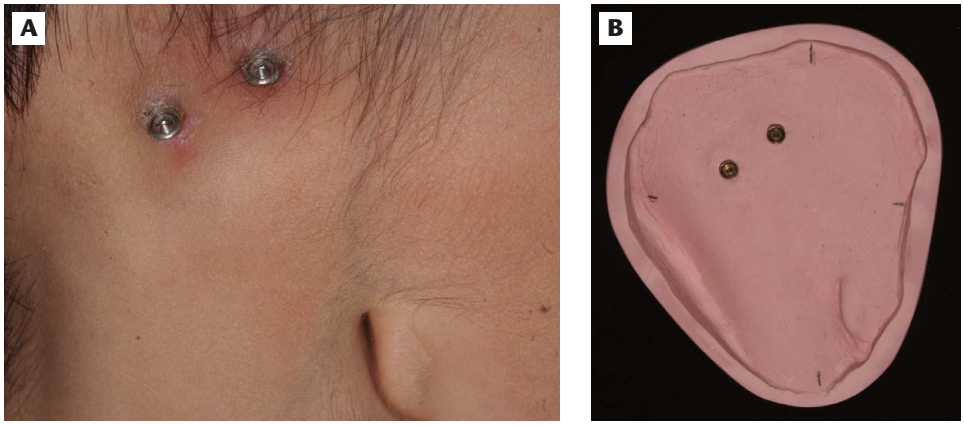

Figure 3. *(A) Six weeks post-surgical placement of craniofacial implants. (B) Impression was poured in Type IV stone (Silky Rock).*

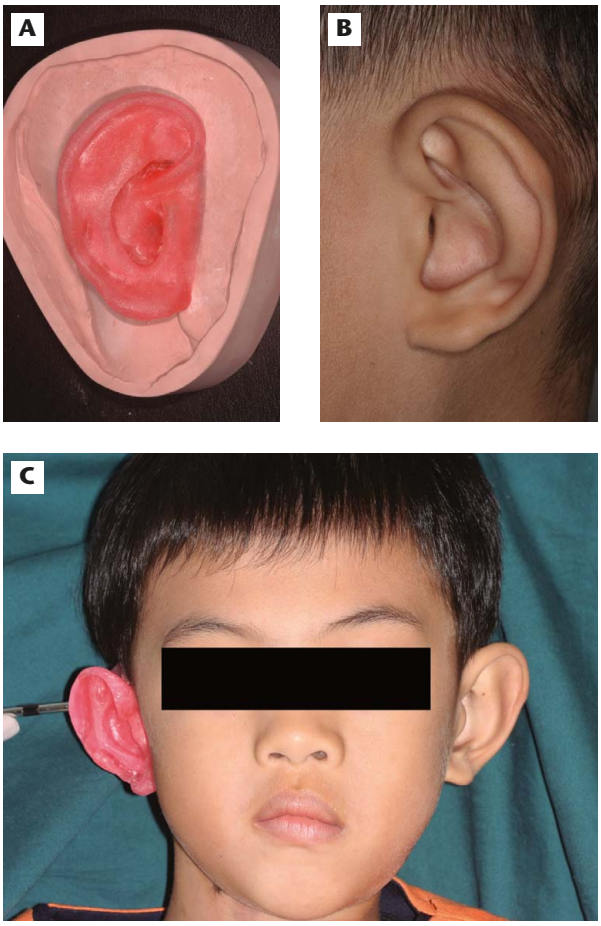

Figure 4. *(A) Wax sculpturing of the auricular prosthesis. (B) Patient's contralateral ear. (C) Wax sculpting was tried on clinically for esthetic assessment.*

on the retentive areas. Undercuts were blocked out with wax (Modelling wax; Dentsply).

An autopolymerized acrylic resin housing (Quick Resin, Shofu, GC, Japan) with 4 clip attachments

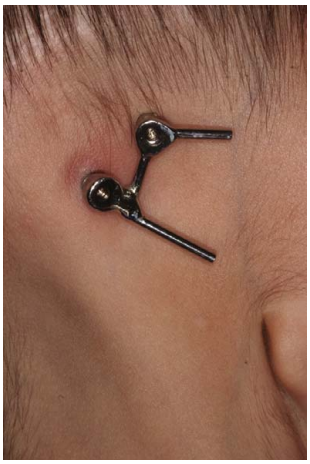

Figure 5. Tissue bar *in situ*.

was fabricated and the flask cope was used to visually check that 2 mm of space allowance was present for the silicone prosthetic material[10] (Figure 6A). Retentive undercuts and perforations were made on the acrylic resin housing (Figure 6A and 6B).

The sculpting and acrylic resin housing were flasked and the wax was boiled out. The acrylic resin housing and tissue bar were finished and processed with silicone elastomer (Dow-Corning 2186; Factor II, Arizona, USA) to complete the auricular prosthesis.

The processed silicone auricular prosthesis was tried on clinically and was extrinsically colored (Earth Color; Factor II, Arizona, USA) to match the patient's complexion. This process was observed and verified with the patient's parents. The auricular prosthesis was delivered to the patient upon curing of the extrinsic coloration. Hygiene and

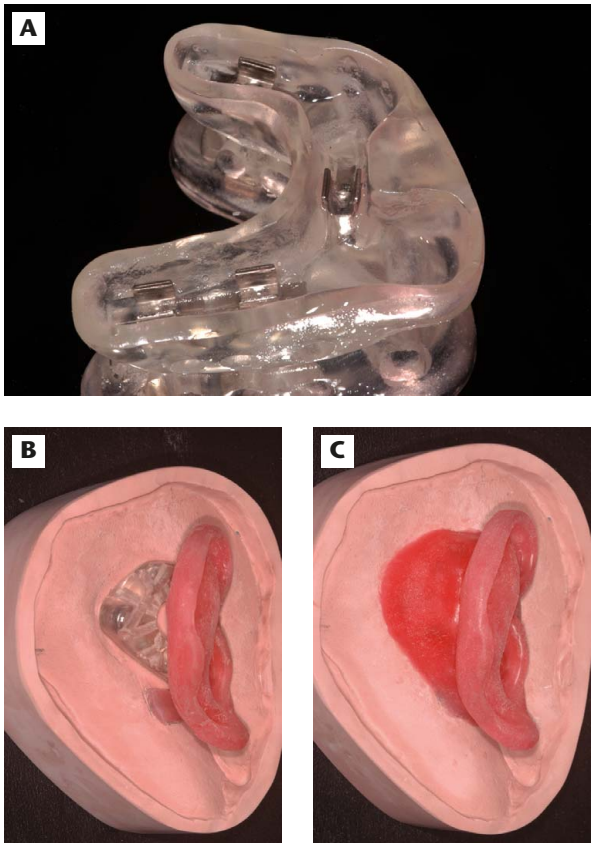

Figure 6. *(A) Acrylic resin housing with four 2 mm clip attachments. (B) Assessment of space allowance for silicone material. (C) Completion of sculpture wax up.*

maintenance instructions were given. At 6 months recall, the patient and parents were still satisfied with the cosmetic result achieved (Figure 7).

Discussion

This case report illustrates the role of the maxillofacial prosthodontist, and the importance of a multidisciplinary approach to management of a young patient with Goldenhar-Gorlin Syndrome. It also validates the method of using a thermoformed shell guide,[10] to ensure proper spatial relationship among the implant tissue bar, retentive elements and external contour of the auricular prosthesis, while not encroaching onto the space of the Bone Anchored Hearing Aid implant.

Replacement of a missing ear in a pediatric patient may be achieved with either surgical reconstruction or prosthetic replacement.[11] While autogenous reconstruction remains the treatment

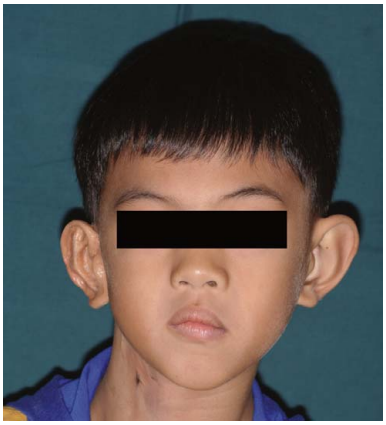

Figure 7. *Auricular prosthesis was extrinsically stained and issued with acceptable aesthetic outcome.*

of choice in pediatric patients with microtia, prosthetic reconstruction of the auricle is considered under the following circumstances: (1) awaiting rib cartilage reconstruction, (2) failed autogenous reconstruction, (3) severe soft-tissue/skeletal hypoplasia, (4) a low or unfavorable hairline, (5) acquired total or subtotal auricular defect and (6) to avoid multiple and longer surgical procedures.[11]

Surgical ear reconstruction in the pediatric patient has the advantage of providing a stable, low-maintenance ear reconstructed from autogenous cartilage framework. It also has the potential to have continued growth of the grafted cartilage over time.[12] However, the patient will need to undergo multiple and longer surgical procedures. Acceptable facial symmetry and aesthetics is more difficult to achieve as compared to a sculptured auricular prosthesis.

On the other hand, prosthetic augmentation confers superior aesthetics at a considerably lower cost and risk to the young patient.

Prosthetic retention is generally achieved via use of anatomical undercuts, use of adhesives, or through the use of implants. In the replacement of an auricular prosthesis, anatomical undercuts usually do not provide any effective retentive elements. Adhesives have been shown to cause degradation and color changes to the silicone prosthesis. Repeated application and removal of the prosthesis may also result in damage to the prosthetic ear as well as tissue irritation to the patient.[13]

Studies have shown greater patient satisfaction with implant retained over adhesive-retained

prosthesis.[14] Osseointegrated craniofacial implants provide enhanced retention, stability, and ease of maintenance of a maxillofacial prosthesis. The use of a craniofacial implant-retained prosthesis has been shown to be a viable alternative to a surgical reconstruction approach.[15] Surgical placement of craniofacial implants is relatively less demanding in comparison with the reconstruction procedure. Success of craniofacial implants has been shown to strongly correlate with anatomic sites and exposure to radiotherapy,[16] with implants placed in the auricular sites displaying the highest success rates among other craniofacial anatomic sites.[16]

On the other hand, failure of osseointegrated implants placed in the temporal bone is still possible. Some patients may also experience redness and irritation around the soft tissues surrounding the implant. Occasionally, granulation tissue may form around the abutment resulting in infection of the peri-implant soft tissues and subsequent implant loss.[17] The importance of the patient's compliance with hygiene measures and timely adjustments by the clinician at follow up visits cannot be over-emphasized. Ultimately, replacement of the prosthesis will still be required over time due to degradation of the silicone prosthetic material itself.

It was found that ear width reached its mature size by age 7 and attained its full length by about age 13 in males.[18] The optimal age proposed for a child to begin wearing an auricular prosthesis is between the age of 6 and 9. It is postulated that the child should have attained a certain level of maturity sufficient to want the prosthesis and is also able to help care for it.[19] Compared with surgical auricular augmentation, prosthetic reconstruction would allow periodic adjustment to account for the change in ear size in growing individuals. During the discussion of treatment options with the parents, special consideration was given to advise them on the necessity for several replacements of the prosthesis throughout the child's growth phase.

Adolescents with craniofacial anomalies have demonstrated elevated risk for problems with academics and peer relationships.[20] It has been reported that 75% of adolescents with craniofacial anomalies cited teasing or bullying about their appearance as causing considerable distress.[21] Studies have shown that children with facial anomalies received lower preferences as playmates than other physical differences. This behavior of social avoidances among children, which appears to be similar in other parts of the world, may account for an increased risk of impaired psychosocial functioning and stigma experiences in children and young adults with craniofacial anomalies.[22] It may be imperative that some form of surgical/prosthetic reconstruction be provided for even a young child to facilitate normal social interaction with peers and to improve their overall psychosocial well-being.

The external ear is a challenging prosthesis to fabricate. Aesthetic appearance has since gained greater emphasis in society, and a missing right ear will have a significant psycho-social impact on a growing child. It is therefore beneficial for the defects of a hemifacial microsomia patient to be managed as early as possible consistent with the patient's ability to manage the prosthesis.

Summary

This article outlined the maxillofacial prosthetic management of a young individual with hemifacial microsomia.

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Scientific Poster

A Land Untouched by Dentistry – Singapore Brings Dental Care to Afghanistan

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Abstract

In 2007, the Singapore Armed Forces deployed a Dental Project Team (DPT) to the capital city of the Bamiyan Province in Afghanistan. The team set up the province's first modern dental facility. Besides providing primary dental care to the 60,000 population there, the Singaporeans also trained and prepared a team of Afghan dentist and dental assistants. The Afghan dental team took over the dental clinic and continued to provide care when it was time for the DPT to depart for home. Braving challenging security and austere living conditions, the DPT completed its mission successfully. [*Singapore Dent J* 2011;32(1):39–48]

Key Words: dentistry, Afghanistan, Singapore Armed Forces

Introduction

Most of the people in Afghanistan have no basic dental care. The years of war have taken its toll on the country's infrastructure and basic services including health care. Many Afghans have not seen a dentist or visited a dental clinic.

In 2007, the Singapore Armed Forces (SAF) deployed a Dental Project Team (DPT) to the Bamiyan Province in Afghanistan to build the first dental clinic for the 60,000 strong population there. Bamiyan Province is one of the 34 provinces of Afghanistan and is in the centre of the country. Its capital is also called Bamiyan (Figure 1).

The DPT was deployed in Bamiyan from 16 May to 12 August 2007 with the mission to address the lack of dental care there (Figure 2). The team operated with the New Zealand Provincial Reconstruction Team which has been in Bamiyan since 2003. Operating in an austere environment, the DPT overcame challenging conditions to achieve the following objectives:

1. To set up a fully equipped dental clinic in the Bamiyan Hospital.
2. To deliver dental care to the Bamiyan people.
3. To train local dental assistants.
4. To hand over the clinic to an Afghan dentist.

Mission Planning

Prior to deploying to Afghanistan, the DPT underwent rigorous integration training in Palmerston North, New Zealand with the New Zealand Defence Force. The training focused on infantry skills and weapon training. On returning from New Zealand, the DPT continued with their military and fitness training.

At the same time, the team commenced detailed mission planning. The Dental Branch of HQ Medical Corps (HQMC) led by MAJ (DR) Edwin Heng

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Figure 1. *Afghanistan, (i) Aerial view, (ii) Sand storm in Bamiyan, Afghanistan.*

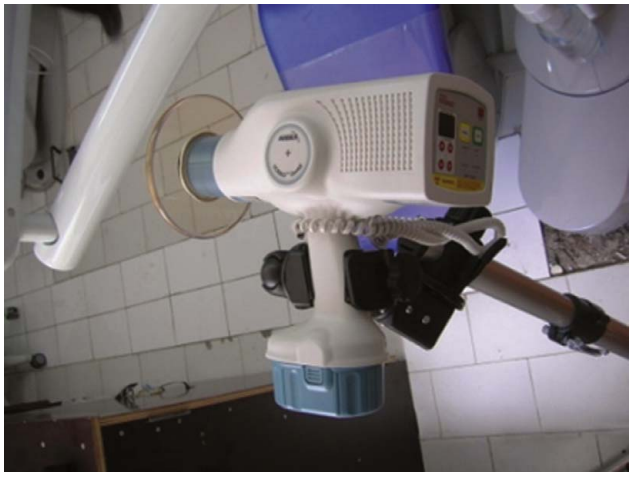
Figure 2. *The Singapore Armed Forces Dental Project Team. MAJ (DR) Bernard Tan (front row first left), MAJ (DR) Wee Chee Wee (front row second from right) and COL (DR) Peng Hui Tan (reserve; back row second from right).*

and DPT coordinated with multiple agencies including the Bamiyan Hospital, Defence Science and Technology Agency, an established Singapore dental supplier company and a dental company in Afghanistan. A two-chair dental clinic was planned after analysing the dental needs as well as the availability of water and electricity in Bamiyan (Figure 3).

The dental clinic was to be set up in the Bamiyan Hospital. The single-floor hospital building comprised eight rooms connected by a corridor. The room set aside for the dental clinic was the best room the hospital could spare. It measured $5 \times 4\,m^2$. There was no extra space for a sterilisation room because of the small building size (Figure 4).

Based on the floor plan of the room supplied by the Bamiyan Hospital Administrator, Dental Branch HQMC and DPT planned the dental clinic in consultation with the Singapore dental company, which was supplying the dental equipment (Figure 5).

It was arranged for the equipment to be procured and shipped from a neighbouring country to Bamiyan, where they would be installed by local technicians. As part of contingency planning,



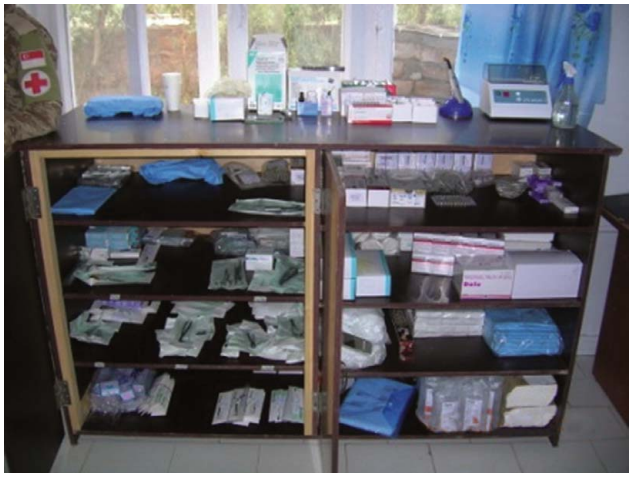


Figure 3. *Bamiyan's first modern dental clinic, (i) The state-of-art dental chair, (ii) Hand held digital dental X-ray machine, (iii) Well-supplied clinic.*

the DPT was trained to assemble the dental chairs if necessary (Figure 6).

After the clinic design, which included the location of the dental chairs, was finalised, it was forwarded to the Afghan dental company with instructions to lay the floor piping. Once the

Figure 4. *Sterilisation corner of the clinic.*

Figure 5. *DPT inspecting the floor of the dental clinic room on their arrival in the Bamiyan Hospital.*

Figure 6. *Prior to deployment, DPT members learned to assemble the dental chair.*

Afghan technicians had laid the pipes, they would forward photographs of the completed work to the Singapore dental company. The piping needed to be ready so that the dental chairs could be installed as soon as they arrived in Bamiyan.

Setting Up the Dental Clinic

The setting up of the dental clinic began on 27 May 2007 with the arrival of the DPT in Bamiyan. They started with the installation of the two dental chairs as the Afghan technicians had no previous experience assembling the German-made dental chairs. They were assisted with step-by-step instructions supplied by the Singapore dental company. Senior technicians of the company provided support by conveying instructions over the phone. The Compressor Room was constructed outside the dental clinic (Figure 7).

The technician team of the Afghan dental company comprised two Afghans and one Pakistani national. The Pakistani technician led the installation of the chairs, assisted by the Afghan technicians, who also served as interpreters (Figure 8).

The modern dental chairs had automatic cut-off switches to the motor powering the chair. These switches prevent damage to the chair when its movements are impeded by obstacles. These complex electrical circuits require in-depth knowledge. Although the Pakistani technician was a skilful electrician, it took him some time to connect and correct electrical faults encountered during the assembly of the chairs.

The installation of the dental chairs was completed on 31 May 2007. The DPT carried out the user acceptance test to ensure that the chairs were in working order. The clinic also received further furnishing, a new coat of paint, new sinks and custom-made furniture, built by New Zealand Defence Force combat engineers and local staff.

Initially, the power supply could not meet the increased wattage demand of the clinic, resulting in occasional tripping of the electrical supply. Electrical rewiring of the clinic was carried out. The DPT adopted the same standard of infection control practised in SAF dental centres. This strict standard of care was audited and approved by the hospital management. In a simple ceremony held on 10 June 2007, the clinic was declared open (Figure 9).

Figure 7. *The compressor room outside the clinic.*

Figure 8. *Dental chairs assembled! DPT posed with the Afghan-Pakistani Technician Team.*

Delivering Dental Care

The demand for dental care grew steadily following the opening of the clinic. The swelling crowd and intrusions were a growing security concern. On several occasions, the locals would enter the clinic, demanding treatment. There were many patients who presented dental ailments that do not require urgent treatment. Some had to be turned away as the clinic was getting overcrowded.

On occasions when patients insisted to be seen, the Dental Supervisor would take on the role of clinic manager and mediate the situation.

Figure 9. *A simple ceremony attended by local Afghan officials, marked the opening of the Dental Clinic in the Bamiyan Hopsital.*

Figure 10. *Afghans registered for care outside the dental clinic.*

Figure 11. *Patients waited for their turn outside the dental clinic.*

As a security measure, the door to the clinic was kept locked at all times and patients were allowed into the clinic in an orderly manner (Figures 10 and 11).

In the first week, a daily cap on patient numbers was set. This was mainly because the dental assistants were still being trained on the job (Figure 12). It was also deemed preferable to complete as much treatment as possible for each patient as some had travelled long distances to seek care. With these control measures, the patient crowd became more manageable.

Training Local Dental Assistants

Besides providing care to the patients and running the clinic, the DPT also trained the local Dental Assistants (DA). The team conducted a two-week course on practical skills. It also organised a dental awareness workshop for 18 healthcare workers from the various districts of Bamiyan Province including doctors, nurses and midwives (Figure 13).

The training programme, which was well received, imparted assisting skills and knowledge on triage and preventive dentistry. Certificates were presented to the healthcare workers who had completed the training. The DPT also delivered dental health talks to more than 200 students and teachers in the local schools (Figures 13 and 14).

The DA course contents were prepared by the Dental Branch of HQMC. It was adapted from the four-week SAF DA Course and focused mainly on hands-on skills. The instructors further adjusted the training along the way to meet local classroom learning conditions. At the end of the course, the teaching materials were donated to the hospital for future refresher training (Figure 15).

Figure 12. *DPT training the Afghan dental assistants. (i) In the classroom, (ii) In the clinic.*

Figure 13. *MAJ (DR) Wee Chee Wee taught Afghan students oral hygiene techniques.*

Figure 14. *Oral hygiene products for the local children.*

The DPT members also interacted with the sole local dentist in Bamiyan. They found him professionally competent. He shared his experiences in the management of cellulitis and abscesses that had spread beyond the primary spaces of the jaw while his SAF colleagues taught him endodontic procedures and modern restorative techniques. As he was the only dentist in Bamiyan, he would face a heavy workload in the future (Figure 16).

Figure 15. *Afghan participants of the Dental Assistant Course.*

Learning the Local Cultures

The mission gave Singaporeans the opportunity to learn about the Afghan culture, customs and etiquette. For example, in Afghanistan, male and female patients would wait in separate queues. The removal of footwear before entering the room was expected. Patients would enter the dental clinic without their shoes (Figure 17). However, military personnel were exempted from this

Figure 16. *MAJ (DR) Bernard Tan shared knowledge with his Afghan colleague.*

Figure 17. *Shoes left outside at the clinic door*.

practice. This was because soldiers might need to move and respond swiftly to emerging situations. To do so, they would need their boots on even when indoors. This requirement was carefully explained to the local staff and was accepted.

Patient Load

The DPT treated a total of 523 patients and completed 806 treatment procedures (Figure 18).

Age profile

The majority of the patients who attended the dental clinic were between 17 and 30 years of age. The number of paediatric patients was small (Table 1). This was probably because Afghan parents were less familiar with the childhood dental

Figure 18. *The Afghan people in Bamiyan.*

Table 1. Patient age profile

Age (years)	Number of patients	Percent (%)
0–1	1	0.1
1–6	12	1.5
7–16	87	10.8
17–30	430	53.3
31–40	155	19.2
41–60	108	13.4
61–70	13	1.6
Total	806	100

diseases. Some paediatric patients (aged above 12 years) came without their parents or guardians (Figure 19). Most of the time, they required non-invasive treatment.

Gender of patients

Initially, the DPT expected fewer female patients. It was believed that Afghan women required the permission of their husbands or parents to seek medical care. It turned out that the dental clinic saw more female than male patients. These female patients removed their veils when they were on the dental chairs and did not request their husbands or parents to be present during the treatment. The women were also observed to be more persistent than the men. There were times when the clinic had to turn away female patients with non-urgent dental ailments. However, some of these women were insistent that they be given care. The patient gender profile is outlined in Table 2.

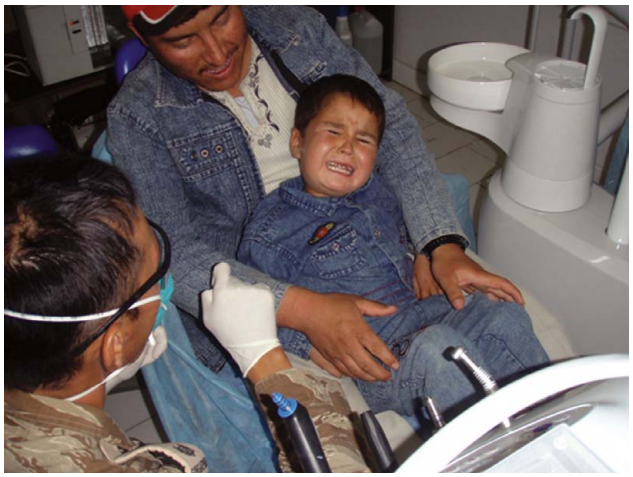


Figure 19. *Young patients in the Bamiyan dental clinic.*

Table 2. Patient gender profile

Gender	Number of patients	Percent (%)
Female	413	51.2
Male	393	48.8
Total	806	100

Table 3. Reasons for visits

Reasons for visits	Number of complaints	Percent (%)
Pain	596	73.90
Pain and swelling	2	0.2
Swelling	5	0.6
Check-up	90	11.2
Secondary care	4	0.5
Others	109	13.5
Total	806	100

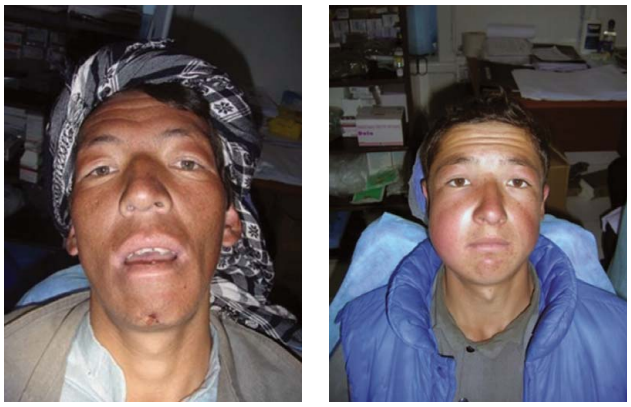


Figure 20. *Tooth abscess, cellulitis and fistula.*

Reasons for visits

Pain was the most common reason for visiting the dental clinic. It was mostly dental pain, varying from mild to severe. If the pain was associated with swelling, the case was treated as an emergency and care was provided on the same day. Most of the residents in Bamiyan and surrounding districts do not have access to dental care. The accessibility to the Bamiyan Hospital was poor because of limited road infrastructure. Most of the locals with emergency needs do not travel to the hospital. Instead, they would seek care at the district clinics. A few requests for dentures could not be met due to the lack of materials and laboratory support. The reasons for visits are outlined in Table 3.

Diagnoses of dental complaints

Most of the dental diseases resulted from caries and gum diseases (Figure 20).

Generally, the dental clinic would complete as much treatment as possible for each patient. Hence, several procedures were carried out

Table 4. Diagnoses of complaints

Diagnosis	Frequency	Percent (%)
Acute local perio	2	0.2
Alveolar osteitis	1	0.1
Asymptomatic PA endo	1	0.1
Bone trauma	1	0.1
Caries incipient	2	0.2
Caries into dentine	252	31.3
Caries into pulp	215	26.7
Chronic perio	37	4.6
Crowding	1	0.1
Dental trauma	10	1.2
Hard tissue lump	1	0.1
Incipient caries	28	3.5
Non-caries cavity	8	1.0
Perio others	19	2.4
Endo others	12	1.50
Partial/full edentulism	2	0.2
Periodontitis	1	0.1
Retained primary	1	0.1
Root stump	129	16.0
Severe gingivitis	66	8.2
Soft tissue growth	3	0.4
Soft tissue infection	1	0.1
Soft tissue trauma	1	0.1
Symptomatic PA endo lesion	11	1.4
Trauma	1	0.1
Total	806	100

Table 5. Treatment types

Treatment types	Frequency	Percent (%)
AR	46	5.7
Consultation	59	7.3
CR	11	1.4
Desensitisation	1	0.1
Drug therapy	13	1.6
Excision	1	0.1
Extraction	335	41.6
GIC	219	27.2
Incision and drainage	3	0.4
LA Op removal	5	0.6
Pulp capping	3	0.4
Pulp therapy of primary	4	0.5
Pulpectomy	1	0.1
RCT of permanent	5	0.6
Root planing	2	0.2
Scaling	83	10.3
STO	1	0.1
Temp filling	12	1.5
Trauma management	2	0.2
Total	806	100

Figure 21. *Mission accomplished. DPT handed over the dental clinic to the Afghan dental team.*

Figure 22. *Singapore dental mission to Bamiyan, Afghanistan.*

during the same visit. This was for the convenience of the patient. Also, several procedures could be performed on the patient with one set of instrument, maximising the use of the sterilised instrument and expendables. The diagnoses of dental complaints are given in Table 4.

Type of treatment

The treatments rendered were mainly extractions, fillings and scaling. Extractions were done as definitive treatment could not be carried out due to the lack of equipment for root canal treatment.

Glass-Ionomer Cement (GIC) fillings were used to restore tooth cavities because of ease of preparation and quick delivery. The types of dental treatment administered are outlined in Table 5.

Handing Over the Clinic

As the DPT neared the end of its mission, preparation was made to hand over the dental clinic to the local Afghan dentist. As assessed by the DPT, the local dentist had the professional competence to take over the running of the clinic. By the end of June, the Afghans were effectively running the dental clinic. They were ready for a handover, which was completed smoothly (Figure 21).

The dental mission to Afghanistan was instructive for the SAF DPT. It was humbling to see the Afghans happy with what little they had in life. The people there expected little and had little. Throughout the mission, smiles were shared between the people of different worlds. The team would not forget the mission any time soon. We realised just how good we have it back home (Figure 22).

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Articles should be written in English (British English spelling) and meet the following basic criteria: the material is original, the information is important, the writing is clear (clinical or laboratory jargon is to be avoided), the study methods are appropriate, the data are valid, and the conclusions are reasonable and supported by the data.

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Each manuscript should state the objective/hypothesis, design and methods (including the study setting and dates, patients/participants with inclusion and exclusion criteria, or data sources and how these were selected for the study), the essential features of any interventions, the main outcome measures, the main results, discussion placing the results in context with the published literature, and conclusions. Typical length: 2000–3000 words.

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Please include a statement identifying grants, pharmaceutical sponsorship, and other acknowledgements as appropriate.

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3. Olszewski R, Reychler H. Limitations of orthognathic models surgery: theoretical and practical implications. *Rev Stomatol Chir Maxillofac* 2004;105:165–9. [In French]

Books:

1. Stevens J. *Applied Multivariate Statistics for the Social Sciences*, 3rd edition. New Jersey: Lawrence Erlbaum Associates, 1996.
2. Sapp JP, Eversole LR, Wysocki GP. Infections of Teeth and Bone. In: Sapp JP, Eversole LR, Wysocki GP. *Contemporary Oral and Maxillofacial Pathology*, 2nd edition. St Louis: Mosby, 2004:70–93.

Report:

1. Committee on Mercury Hazards in Dentistry. *Code of Practice for Dental Mercury Hygiene.* London: Department of Health and Social Security, 1979, publication no. DHSS 79-F-372.

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