Orthodontic Treatment Need of Adolescents in the Island Community of Haida Gwaii, Canada

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Abstract

The aim of this study was to determine the prevalence of malocclusion and orthodontic treatment need according to the Index of Complexity, Outcome, and Need (ICON) among schoolchildren of the island community of Haida Gwaii in northwestern British Columbia, Canada. Two elementary and two high schools in Haida Gwaii were approached for census sampling. Out of 535 schoolchildren, 215 (90 boys and 125 girls) agreed to participate (40.2% response) in this cross-sectional epidemiological study. A trained examiner assessed orthodontic treatment need in children employing the ICON score and the ICON complexity grade. The mean age (N = 215) was 12.9 ± 2.8 years. Of the examined schoolchildren, 67% had Aboriginal ancestry (at least one Aboriginal parent). The mean ICON score (N = 215) was 43.5 ± 26.2. There were no statistically significant differences in ICON scores for gender (t test, p = 0.207), ethnicity (t tests: paternal ethnicity, p = 0.886 and maternal ethnicity, p = 0.389), or school (ANOVA with post hoc Bonferroni adjustment, p = 0.317). Overall, 43.7% of the surveyed Haida Gwaii adolescents needed orthodontic treatment (ICON > 43). Based on the ICON complexity grade, 31% of the schoolchildren had moderate to very difficult malocclusions; therefore, specialty orthodontic services are recommended in this remote community.

Keywords

Aboriginal, Haida Gwaii, malocclusion, orthodontics, adolescent, Skidegate, Masset, ICON

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Introduction

The crowding or malalignment of teeth, commonly called malocclusion, can be a health problem (Shaw, O'Brien, Richmond, & Brook, 1991). Malocclusion can lead to problems with oral function (chewing, swallowing, and speech), difficulties in jaw movement, discrimination due to facial appearance, and greater risk for trauma, periodontal disease, or tooth decay. Its etiology is multifactorial and is influenced by genetic and environmental factors (Shaw et al., 1991).

A recent Canadian Health Measures Survey (CHMS) conducted by Health Canada in 2007–2009 included an oral health component that measured malocclusion (Health Canada, 2010). Occlusal conditions, including crossbite, severe crowding/spacing, and excessive overbite/overjet were recorded and the prevalence of malocclusion (less than acceptable occlusion) among all 12- to 59-year-old Canadians was 24.0%, 95% CI [20.9, 27.5]. Malocclusion among all young adults (20- to 39-year-olds) was 24.3%, 95% CI [21.2, 27.6], while it was less prevalent at 18.5%, 95% CI [15.2, 22.3] among adolescents 12 to 19 years old (Health Canada, 2010).

Limited studies document malocclusion among Aboriginal Peoples in Canada. Zammit (1993) discovered that 95% of Labrador Inuit youth had some degree of malocclusion and a need for orthodontic care. Harrison and Davis (1996) documented that First Nations adolescents in British Columbia had more crowding, Class III dental relationships, and anterior open bites than their Euro-Canadian counterparts. In 2002, Cadman, Glover, Heo, Warren, and Major compared 60 First Nations orthodontic patients to 60 non–First Nations orthodontic patients; the First Nations patients had greater pretreatment malocclusion as evidenced by their significantly higher pretreatment Peer Assessment Review (PAR) scores compared to the non–First Nations patients.

Currently, British Columbia ranks second provincially in absolute numbers (196,795) of Aboriginal people (Ontario: 242,495, Alberta: 188,365, and Manitoba: 175,395) (Statistics Canada, 2007). Among the Aboriginal population in British Columbia is the island community of Haida Gwaii, previously known as the Queen Charlotte Islands. This archipelago lies off the north coast of British Columbia and has a population (mostly Aboriginal) of approximately 4,700 (Go Haida Gwaii, 2012). The islands are connected to mainland British Columbia by daily scheduled air service from two small airports and by year-round ferry service (Go Haida Gwaii, 2012).

There are two dental clinics (affiliated and run by the University of British Columbia's Faculty of Dentistry) in Haida Gwaii, one in the northern town of Masset and the other in the southern town of Skidegate (General Practice Residency [GPR] Programs at UBC, UBC

Dentistry Impressions fall 2012); each is staffed by a receptionist and a dental assistant. Haida Gwaii residents receive regular dental care (hygiene services, preventive care, direct restorations, root canal treatment, extractions, crowns, bridges, etc.) from dental residents of the Graduate Residency Program at the Faculty of Dentistry, University of British Columbia (UBC; GPR Community Programs at UBC, 2012). At present, orthodontic services are not provided at these dental clinics; individuals have to go off island for orthodontic treatment.

The aim of this study was to conduct a cross-sectional epidemiological survey of Haida Gwaii adolescents to determine the prevalence of malocclusion and orthodontic treatment needs. The results of this assessment could help to strategize the on-island implementation of orthodontic services by expanding current dental outreach services provided by UBC.

Methodology

Ethics and Memorandum of Understanding

A Memorandum of Understanding was signed by the local Haida Gwaii band leaders, the UBC Graduate Orthodontics Department, and the UBC Dental Graduate Residency Program. The study was also approved by the Clinical Research Ethics Board at UBC (Certificate Number H11-02446).

Study Population

Two elementary and two high schools in Haida Gwaii were approached for census sampling of adolescents. Letters were sent to the principals, schoolteachers, and parents or guardians of the children, to inform them about the examination procedure, to assure them of the confidentiality of the information collected, and to seek consent for the children's' participation. Posters were put up in the schools and community centres. A 10-dollar iTunes card was given to every participant.

Out of 535 schoolchildren, 215 (90 boys and 125 girls) obtained parental consent and agreed to participate (40.2% response rate). The age range of the schoolchildren was 7–18 years. Criteria for exclusion of any participant included previous orthodontic treatment, cleft lip or palate, and any other relevant syndrome.

Clinical Examination

The index used to assess malocclusion in this adolescent population was the Index of Complexity, Outcome, and Need (ICON; Brook & Shaw, 1989; Daniels & Richmond, 2000). The ICON was developed to assess orthodontic treatment need, treatment complexity, and treatment outcome. The ICON scoring system evaluates five clinical traits: dental aesthetics by the Aesthetic Component of the Index of Orthodontic Treatment Need (IOTN), upper arch crowding or spacing, crossbite, incisor vertical relationship (open bite or over bite), and buccal segment (anteroposterior relationship). Once all categories are scored and appropriately weighted, they are summed for a total ICON score. The ICON scoring can be done on mixed dentition or permanent dentition either clinically or on study models with accompanying orthodontic photographs. A score greater than 43 indicates that the components of the malocclusion are complicated enough and that orthodontic treatment is needed. The ICON categorizes how difficult or complex a malocclusion is to treat as follows: < 29 = easy to treat, 29–50 = mild complexity, 51–63 = moderate complexity, 64–77 = difficult to treat, and > 77 = very difficult to treat (Daniels & Richmond, 2000).

Prior to the clinical examinations in Haida Gwaii, intra-examiner reliability was tested. A total of 35 patients from the UBC Graduate Orthodontic Clinic were examined and re-examined two weeks later (using standardized digital pretreatment orthodontic study models and photographs) with the ICON. No radiographs or previous dental records of the participants were used. The Pearson correlation coefficient was between .87 and .98 ($p < 0.001$) for the five traits being measured by the ICON, indicating a high level of agreement, that is, reproducibility of the ICON scores.

In Haida Gwaii, a single trained examiner (graduate orthodontic resident) conducted the examinations in a well-lit room at each school. A simple chair was provided for participants to be seated during the examination, and disposable gloves, measuring probes, and tongue retractors were used for the direct examination in the knee-to-knee position. A community health worker was paid a daily stipend for assistance. Participants were not immediately informed of the results of their assessment. Once all the data from the examinations were collected and processed, a list was generated for each school principal showing the need for orthodontic treatment for each participant. Participants with high ICON scores were encouraged by notification from the principal to get dental checkups to further assess their orthodontic needs.

Statistical Analyses

Data from the examinations at the schools were recorded on examination forms and then entered into Microsoft Excel. Data processing and analyses were carried out using the Statistical Package for Social Sciences, version 20.0 (SPSS Inc., Chicago, IL). For the descriptive statistics, categorical variables were expressed as percentages and quantitative variables as means and standard deviations. Gender- and ethnicity-related differences, with respect to ICON scores, were tested by the independent sample *t* test. To compare schools, age groups, and ancestry categories, analysis of variance followed by post hoc Bonferroni adjustment was used, and the complexity scores relative to gender were analyzed by the Pearson chi-square test.

Results

The mean age of the examined population ($N = 215$) was 12.9 ± 2.8 years; for males it was 13.5 ± 2.6 years and for females it was 12.6 ± 2.9 years.

Orthodontic Treatment Need

Orthodontic treatment need (as indicated by an ICON score > 43) was found in 43.7% (94) of the 215 examined adolescents. The mean ICON score ($N = 215$) was 43.5 ± 26.2. In Table 1, analysis of variance showed no statistically significant differences between the age groups; however, the eldest age group (16- to 18-year-olds) had the highest ICON score. Figure 1 shows the range of ICON scores related to gender. Although females tended to have lower ICON scores than males, there were no statistically significant differences in ICON scores regarding gender; the mean ICON score for males was 46.1 ± 26.6 and for females, the mean ICON score was 41.5 ± 25.9 (independent sample *t* test, $p = 0.207$). Elementary schools had lower ICON scores than their respective high schools; however, these differences were not statistically significant.

Table 1
Orthodontic Treatment Need Relative to Age as Assessed by ICON

Age Group	Number of Students examined (%)	Mean ICON Score ± Standard Deviation
<10 y (6-10)	28 (13)	44.4 ± 25.2
10-12y	50 (23)	36.3 ± 21.9
13-15y	91(42)	44.1 ± 27.1
16-18y	46 (21)	49.4 ± 28.3
Total	215 (100)	43.5 ± 26.2
ANOVA One way P=0.158; Post Hoc Bonferroni adjustment P=0.139		

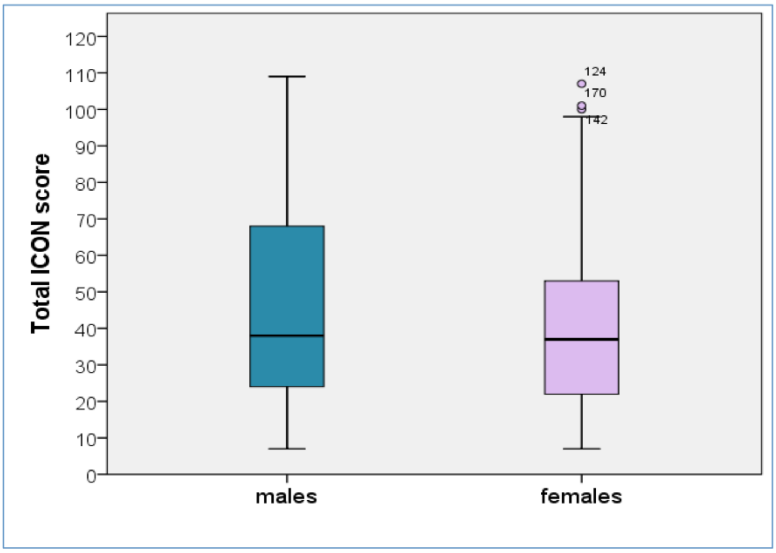

Figure 1.
Orthodontic treatment need ICON scores for male and female adolescents in Haida Gwaii

Independent sample t-Test, Mean ICON score for males = 46.1 ± 26.6 and females = 41.5 ± 25.9, P=0.207; circles represent outliers.

With respect to ethnicity, 67% of the examined adolescents were of Aboriginal ancestry (32% had one parent who was Aboriginal and 35% had two Aboriginal parents) and 33% were non-Aboriginal. Table 2 shows that adolescents with Aboriginal fathers had similar ICON scores to those with non-Aboriginal fathers

Table 2
Orthodontic Treatment Need Relative to Paternal and Maternal Ancestry as Assessed by ICON

Parental Ancestry	n (number)	Mean ICON Score (Standard Deviation)
Paternal		
Aboriginal	108	43.7 (26.8)
Non-Aboriginal	107	43.2 (25.6)
Total	215	

Independent sample *t* test, *p*=0.886		
Maternal		
Aboriginal	113	45.0 (27.9)
Non-Aboriginal	102	41.9 (24.4)
Total	215	
Independent sample *t* test, *p*=0.389		

Adolescents with Aboriginal mothers had slightly higher ICON scores than those with non-Aboriginal mothers, but the difference was not significant. Analysis of variance showed that there were no significant differences among adolescents having two Aboriginal parents, one Aboriginal parent, or two non-Aboriginal parents (Table 3).

Table 3
Orthodontic Treatment Need Relative to Parental Ancestry as Assessed by ICON

Aboriginal Ancestry	n (number)	ICON Score (Standard Deviation)
Both parents Aboriginal	75	45.9 (28.3)
One parent Aboriginal	69	40.9 (25.2)
Both parents non-Aboriginal	71	43.3 (25.0)
Total	215	
One-way ANOVA $p = 0.524$; post hoc Bonferroni $p = 0.769$		

Orthodontic Treatment Complexity

Table 4 shows the overall grades of orthodontic complexity and orthodontic complexity by gender. Moderate to very difficult complexity grades were found for 31% (66) of the examined adolescents and easy to mild complexity grades for 69% (149). The Pearson chi-square test revealed no statistically significant gender differences in complexity grades.

Table 4
Orthodontic Treatment Complexity Relative to Gender as Assessed by ICON

	Adolescents by Gender		Total Adolescents
	Male (*n* / %)	Female (*n* / %)	(*n* / %)
ICON Complexity Grade			
Easy (< 29)	28 / 31.1	44 / 35.2	72 / 34
Mild (29–50)	31 / 34.4	46 / 36.8	77 / 35
Moderate (51–63)	6 / 6.7	10 / 8.0	16 / 7
Difficult (64–77)	8 / 8.9	9 / 7.2	17 / 8
Very Difficult (> 77)	17 / 18.9	16 / 12.8	33 / 16
	90 / 100	125 / 100	215 / 100
Pearson chi-square test $p = 0.750$			

Limitations

This study examined 40.2% of the school population through census sampling. Given this response rate, there is a possibility that the examined adolescents ($N = 215$) may not accurately reflect the orthodontic treatment needs of all adolescents in Haida Gwaii schools. A power calculation suggested that the appropriate sample size should consist of 502 males and 502 females; however, this was not feasible as the total number of Haida Gwaii adolescents was 535.

Given the limitations of a relatively small cohort size in Haida Gwaii, enhanced recruitment to include all Haida Gwaii adolescents should be considered. Another potential selection bias relates to gender distribution in the present study, as there were more girls (N = 125) than boys (N = 90). A possible explanation for the gender difference is that females may be more concerned about their facial appearance and dental status than males, and consequently females were more likely to seek a checkup in anticipation of treatment.

Discussion

Orthodontic Treatment Need of Haida Gwaii Adolescents

This is the first study to assess the malocclusion of adolescents in the remote island community of Haida Gwaii and to establish that a significant number of these adolescents need orthodontic treatment.

The prevalence of malocclusion (as defined by an ICON score > 43) in the examined Haida Gwaii adolescents was 43.7%, more than double that reported in all Canadian adolescents in the CHMS (18.5%) (Health Canada, 2010). This variance may be explained by differences in sampling. The CHMS had a sample of 6- to 19-year-olds that was approximately 95% non-Aboriginal and 5% Aboriginal (Health Canada, 2010), while the present study of 7- to 18-year-olds had 67% Aboriginals and 33% non-Aboriginals. As such, it appears that Haida Gwaii adolescents (majority with Aboriginal ancestry) have a higher orthodontic treatment need than most Canadian adolescents (CHMS). Comparative data from the CHMS confirm this: Non-Aboriginal adolescents had a malocclusion prevalence of 17.0%, while Aboriginal adolescents had a malocclusion prevalence of 43.1% (Health Canada, 2010). As we explain below, factors other than race/ethnicity per se are the likely root cause of this variance.

Our results are consistent with studies that found no statistically significant differences in gender when assessing orthodontic treatment need with the ICON (Aikins, daCosta, Onyeaso, & Isiekwe, 2011; Liepa, Urtane, Richmond, & Dunstan, 2003; Ngom, Diagne, Diop-Ba, & Thiam, 2007). Although the difference was not statistically significant, potentially due to a relatively small sample size, our results show that males tended to have higher mean ICON scores than females (46.1 versus 41.5) and more "very difficult" malocclusions (19%) to treat than females (13%). This difference is clinically relevant given that orthodontic cases with higher pretreatment ICON scores take longer to treat (Onyeaso & BeGole, 2006; Richmond et al., 2001). Thus, adolescents with higher ICON scores should be informed that their orthodontic treatment will probably take longer than average compared to those with lower ICON scores.

Assessing orthodontic treatment need in the larger context of overall oral health is important. Good oral hygiene and freedom from caries (cavities) is the foundation for good oral health and successful orthodontic treatment; if an adolescent has compromised oral hygiene or caries, malocclusion can result (Shaw et al., 1991). Some studies reported that the presence of malocclusion and orthodontic treatment need are closely related to dental caries and poor oral hygiene (Gabris, 2006; Nobile, Pavia, Fortunato, & Angelillo, 2007). Gabris (2006) showed that Hungarian adolescents with malocclusion had statistically significant higher caries rates (using the decayed, missing, and filled permanent teeth [DMFT] index) and more plaque (using the visible plaque index [VPI]) than adolescents without malocclusion. Nobile et al. (2007) showed that Italian adolescents with a higher DMFT were significantly more likely to require orthodontic treatment. These studies indicate that adolescents with compromised oral hygiene and more

caries consequently exhibit early loss of deciduous teeth and subsequent drifting and crowding of teeth, both contributing to malocclusion (Gabris, 2006; Nobile et al., 2007).

Although our study did not assess the prevalence of dental caries, several Canadian studies have reported the high prevalence of dental caries in Aboriginal youth (Peressini, Leake, Mayhall, Maar, & Trudeau, 2004a; Peressini, Leake, Mayhall, Maar, & Trudeau, 2004b; Schroth, Moore, & Brothwell, 2005; Schroth, Smith, Whalen, Lekic, & Moffatt, 2005; Zammit, Torres, Johnsen, & Hans, 1994). Early childhood caries (ECC), defined as the presence of one-or-more decayed, missing (due to caries), or filled tooth surfaces in any primary tooth in a preschool-aged child, is high among Aboriginal children in Canada (Schroth, Harrison, & Moffatt, 2009), approximately 87% of whom have caries by age five (Leake, Jozzy, & Uswak, 2008). There is a multitude of behavioural, environmental, and socioeconomic risk factors associated with early childhood tooth decay (Leake et al., 2008). Research has revealed that the greatest risk factor for ECC in Aboriginal children is poverty and that about 52% of Aboriginal children live in poverty (Canada National Council of Welfare, 2007; Irvine, Holve, & Schroth, 2011).

The CHMS reported that Aboriginal youngsters (6–11 years old) had a mean dmft (decayed, missing, and filled primary teeth) and DMFT of 6.62, while non-Aboriginal youngsters had a combined dmft and DMFT mean of 2.28 (Health Canada, 2010). Thus, according to the CHMS, Aboriginal youngsters had close to three times the caries experience of non-Aboriginal youngsters. This difference in caries severity between Aboriginal and non-Aboriginal youngsters coincides with the higher prevalence of malocclusion in Aboriginal youngsters (43.1%) as compared to non-Aboriginal youngsters (17.0%) in the CHMS (Health Canada, 2010).

Based on the above information, one can question whether Haida Gwaii adolescents also have high caries rates that have contributed to the prevalent malocclusion (43.7%) in this population. Our results showed that 16- to 18-year-olds had the highest mean ICON score of 49.4, whereas the younger age groups had lower mean ICON scores (36.3–44.4). This trend of older adolescents having higher orthodontic treatment needs was also observed among the schools, where adolescents from both high schools had higher ICON scores (49.9 and 43.5) than adolescents from corresponding elementary schools (38.4 and 41.3). Could compromised oral hygiene, and caries leading to the loss of primary and permanent teeth be contributing factors to changes in the dentition and future malocclusion or worsening of the malocclusion in these adolescents? In order to answer this question and assess the impact of caries on Haida Gwaii adolescents, further information would be required. Such information would include reports on family income, parental education levels, oral hygiene habits with respect to daily brushing and flossing, dietary habits and food availability, community water fluoridation, community oral health education, and access to timely oral health care.

With respect to ethnicity or parental ancestry, there were no statistically significant differences in our study. Based on the above discussion, one would expect adolescents with Aboriginal ancestry to have more malocclusion and higher ICON scores than adolescents with non-Aboriginal ancestry. One explanation for the lack of observed differences between Aboriginal and non-Aboriginal adolescents is the physical remoteness of the community and the scarcity of local dental specialty services like orthodontics. In essence, the geographical location of Haida Gwaii is a significant barrier to health care access, equally affecting children of Aboriginal and non-Aboriginal backgrounds.

The lack of access to timely dental care in remote Canadian communities is influenced by several factors, including transportation costs, economic constraints, commuting time, and

personal factors (Survey, 2012). The closest orthodontic office for any Haida Gwaii resident is a six-hour ferry ride or a plane trip away. As such, Haida Gwaii residents seeking orthodontic treatment must consider the financial strain of long-distance travel over a long period (comprehensive orthodontic treatment can last on average about two years). Studies have revealed that populations in remote communities cannot afford the transportation cost to access dental services (Survey, 2012). Additionally, adolescents may need to take time off school to travel off island, and their parents or guardians may need to take time off work for the commute and possibly make arrangements for care of other children who stay on island. These difficulties as well as economic constraints may prevent residents of Aboriginal and non-Aboriginal ancestry alike from travelling off island for orthodontic treatment.

Another important consideration for the provision of orthodontic care locally in this remote community is the orthodontic treatment complexity. Approximately 67 of the examined adolescents (31%) had moderate, difficult, or very difficult malocclusions to treat. This is clinically relevant because almost one out of every three adolescents had a malocclusion that requires the skills and technical expertise of an orthodontic specialist. This finding supports the case that Haida Gwaii dental clinics should establish specialty orthodontic care and not deliver orthodontic services from existing general dentist residents who may not be comfortable and skilled with the diagnosis and treatment of complicated orthodontic cases.

Options for Orthodontic Care in Haida Gwaii

This study has revealed that many of the adolescents in Haida Gwaii have a clinical need for orthodontic treatment. Below are several options that explore the possibility of creating sustainable orthodontic care in Haida Gwaii, from most to least preferable.

Option 1: Orthodontist establishes private practice in Haida Gwaii.

The closest orthodontic office to Haida Gwaii is in Prince Rupert, which is either a short flight away or a six-hour ferry ride away. Because the population of Haida Gwaii is small (about 4,700), there may not be a large enough pool of potential patients to keep an orthodontist busy in the long term if he or she were to live in Haida Gwaii and set up a full-time private orthodontic practice in Masset or Skidegate.

Alternatively, an orthodontist could set up a part-time practice in Masset or Skidegate and spend a couple of days a week in Haida Gwaii and the rest of the week elsewhere in BC in another practice; or he or she could live outside of Haida Gwaii and set up a satellite practice in Haida Gwaii, flying in once every four to six weeks for a couple of days to provide care. Such alternatives would require extensive planning for the orthodontist and the staff. Treatment delays might result if there is not an office that is open on a daily or weekly basis to deal with orthodontic emergencies. For example, if a patient's bracket falls off and the patient has to wait three to five weeks to get the bracket rebonded, the tooth may move in an unwanted direction and treatment may need to be stepped back in order to accommodate the change; ultimately, this could cause a delay in treatment. For the satellite practice, another drawback is that the orthodontist would not have an opportunity to fully integrate into the local society and culture. Initially, the community may consider the "fly in" orthodontist as an outsider; however, with regular visits providing continual care over the long term, the orthodontist would have the opportunity to gain the respect and trust of the local residents and be regarded as a dedicated health care provider.

Regular care by the same orthodontic team (the orthodontist and staff), whether they lived in Haida Gwaii or flew in, would be the best option for orthodontic care. Such a setup

would establish genuine commitment to a remote community and would ensure consistency in treatment philosophy and care over time.

Option 2: Graduate orthodontic residents from UBC do clinical rotation in Haida Gwaii as part of their residency.

Several Canadian dental schools require their students to participate in community-based dental programs that serve disadvantaged and remote populations that are unable to access dental care (Brothwell, 2009; Woronuk, Pinchbeck, & Walter, 2004). For example, the dentistry programs at the University of Alberta and the University of Manitoba have successful decades-old dental outreach programs that provide students with external placements in local community dental centres (Brothwell, 2009; Woronuk et al., 2004). These dental centres are usually satellite clinics of the university's main dental clinic and have modern equipment. UBC's Faculty of Dentistry also has a record in developing and implementing community-based dental outreach programs (UBC Faculty of Dentistry, 2015), including those at existing health clinics at Masset and Skidegate.

There would be many benefits to having UBC orthodontic residents provide orthodontic care in rotations at the Masset and Skidegate dental clinics as part of their graduate residency. A clinical rotation to Haida Gwaii would widen the scope of the residents' educational experience; they would have the opportunity to travel to a remote part of BC to provide care to a community and its individuals who otherwise may find it difficult to seek orthodontic services. Such community-based dental education and service allows students to "appreciate the diversity and challenges that health care providers encounter in everyday practice in different community environments" (Brondani, Clark, Rossoff, & Aleksejuniene, 2008, p.1160). Furthermore, by providing treatment outside of the university dental clinic setting, students can improve their sense of cultural awareness and communication skills with different populations and community members and can begin to identify and understand the social and behavioural determinants underlying personal health care decisions in different communities (Mouradian, Berg, & Somerman, 2003; Mouradian & Corbin, 2003; Strauss, Stein, Edwards, & Nies, 2010). Ultimately, experiences in Haida Gwaii may inspire residents to work in smaller communities rather than in large urban centres once they graduate from their orthodontic residency.

In developing an orthodontic outreach program in Haida Gwaii, there would be many challenges and potential obstacles, including facility cost; cost of necessary orthodontic equipment and instruments; program funding; supervising the graduate orthodontic residents over the course of treatment with experienced and caring orthodontists; maintaining a consistent standard of care with the graduate orthodontic clinic at UBC; introducing a new set of residents into the clinics every year; coordinating schedules with the existing Haida Gwaii dental clinics so that other dental services are not disrupted; training appropriate staff to assume roles in orthodontic patient care and management; and collaborating with other dental specialties (pediatric care, oral surgery, and periodontics) to ensure that orthodontic care is delivered with consideration to the overall dental and general health and well-being of the patients.

One of the most important considerations in developing a new university-based outreach program in a predominantly Aboriginal community would be the possible perception among community residents that they are being exploited or experimented on by students. To avoid this, developing and strengthening existing local partnerships would be essential. Partnering with local stakeholders such as the Haida Gwaii bands and collaborating with the newly established First Nations Health Authority would help to ensure that a culturally appropriate program is created to suit the needs and desires of the community. The existing relationships developed

with UBC dental students would aid as a successful foundation for new programs and increased services. Furthermore, engaging the schools and community centres to conduct orthodontic health education and promotion would provide more information and assist in improving oral health.

With considerate and meaningful collaboration, a university-based graduate outreach program could be developed to help the Haida Gwaii dental clinics ensure that there are sustainable orthodontic services with a perpetual source of professional providers for care.

Option 3: Haida Gwaii residents continue to go off island for orthodontic care.

For Haida Gwaii residents, orthodontic services off island require time off school or work (on a regular monthly basis for a long period, usually two to three years), travel (by either plane or ferry), and potential lodging at a hotel. In addition, residents who do not have any dental insurance or government funding must cover the cost of the orthodontic treatment in addition to all the travel expenses associated with the dental appointments off island.

Over time, patients may experience burnout from all of the trips off island and consequently may miss appointments. Absenteeism may delay completion of treatment. Ultimately, if compliance is poor, a patient's treatment may be discontinued (either by the patient or by the orthodontist). Studies have shown that poor patient compliance results in treatment taking longer and can contribute to discontinuation of treatment (Beckwith, Ackerman, Cobb, & Tira, 1999; Fink & Smith, 1992; Fisher, Wenger, & Hans, 2010; Skidmore, Brook, Thomson, & Harding, 2006; Vu, Roberts, Hartsfield, & Ofner, 2008). Orthodontic emergencies (loose brackets, loose bands, loose or poking wires, or other problems) may be a challenge to address quickly when orthodontic care is off island. Such situations may create discomfort for the patient and have the potential to delay treatment.

If patients choose not to complete their care, they may not fully benefit from the orthodontic treatment and their occlusion may not be stable in the long term. For the orthodontic provider, the termination of a case earlier than expected has several implications. First, it may be professionally dissatisfying to be unable to finish a case to the best of one's ability. Second, the orthodontist may have lost valuable working time due to missed appointments from one patient that could have been devoted to other patients. Third, if an orthodontic provider is being reimbursed for care through a government program and the patient stops treatment, the orthodontist may lose revenue because payment through a government program is based on a structured schedule rather than being issued monthly (Health Canada, 2004).

Conclusions

There is a need for specialty orthodontic treatment in the island community of Haida Gwaii based on the following:

- According to the ICON, 43.7% of examined adolescents needed orthodontic treatment.
- Of all examined, 31% of the adolescents had complex malocclusions to treat (16% very difficult; 8% difficult; 7% moderately complex).
- Males had higher mean ICON scores than females (46.1 ± 26.6 versus 41.5 ± 25.9), though this difference was not statistically significant.
- Males had more complex malocclusions than females (19% very difficult versus 13% very difficult), though this difference was not statistically significant.

Currently there is not a dedicated orthodontist (local or fly-in) in Haida Gwaii; establishing such a practice would be the best option for this community. A reasonable alternative would be to

establish a specialty externship with the UBC graduate orthodontics programs to provide sustainable on-island orthodontic care.

References

Aikins, E. A., daCosta, O. O., Onyeaso, C. O., & Isiekwe, M. C. (2011). Orthodontic treatment need and complexity among Nigerian adolescents in Rivers State, Nigeria. *International Journal of Dentistry, 2011*, 6 pages. doi:10.1155/2011/813525

Beckwith, F. R., Ackerman, R. J., Jr., Cobb, C. M., & Tira, D. E. (1999). An evaluation of factors affecting duration of orthodontic treatment. *American Journal of Orthodontics and Dentofacial Orthopedics, 115*(4), 439–447. doi:10.1016/s0889-5406(99)70265-9

Brondani, M. A., Clark, C., Rossoff, L., & Aleksejuniene, J. (2008). An evolving community-based dental course on professionalism and community service. *Journal of Dental Education, 72*(10), 1160–1168.

Brook, P. H., & Shaw, W. C. (1989). The development of an index of orthodontic treatment priority. *European Journal of Orthodontics, 11*(3), 309–320.

Brothwell, D. J. (2009). Outreach and service learning: Manitoba's Centre for Community Oral Health. *Journal of the Canadian Dental Association, 74*(10), 879–881.

Cadman, K. C., Glover, K. E., Heo, G., Warren, S., & Major, P. W. (2002). Orthodontic treatment outcome in a First Nations population in Alberta, Canada: A comparative study. *American Journal of Orthodontics and Dentofacial Orthopedics, 121*(4), 396–402. doi:10.1067/mod.2002.121563

Canada National Council of Welfare. (2007, Fall). *First Nations, Métis and Inuit children and youth: Time to act* (Volume 127). Ottawa, ON: National Council of Welfare.

Daniels, C., & Richmond, S. (2000). The development of the index of complexity, outcome and need (ICON). *Journal of Orthodontics, 27*(2), 149–162. doi:10.1093/ortho/27.2.149

Fink, D. F., & Smith, R. J. (1992). The duration of orthodontic treatment. *American Journal of Orthodontics and Dentofacial Orthopedics,102*(1), 45–51.

Fisher, M. A., Wenger, R. M., & Hans, M. G. (2010). Pretreatment characteristics associated with orthodontic treatment duration. *American Journal of Orthodontics and Dentofacial Orthopedics, 137*(2), 178–186. doi:10.1016/j.ajodo.2008.09.028

Gabris, K. (2006). Prevalence of malocclusions in Hungarian adolescents. *European Journal of Orthodontics, 28*(5), 467–470. doi:10.1093/ejo/cjl027

General Practice Residency (GPR) Programs at UBC. UBC Dentistry Impressions (fall 2012). Retrieved from: http://issuu.com/ubcdentistry/docs/ubc_dentistry_impressions_fall_2012_issuu?e=13161254/10400930

Go Haida Gwaii. (2012). *Haida Gwaii* [web site]. Retrieved from http://www.gohaidagwaii.ca/

Harrison, R. L., & Davis, D. W. (1996). Dental malocclusion in native children of British Columbia, Canada. *Community Dentistry and Oral Epidemiology, 24*(3), 217–221. doi:10.1111/j.1600-0528.1996.tb00845.x

Health Canada. (2004). *Non-insured health benefits orthodontic bulletin*. Retrieved from http://www.hc-sc.gc.ca/fniah-spnia/pubs/nihb-ssna/_dent/2004-08-ortho/index-eng.php

Health Canada. (2010). *Report on the findings of the oral health component of the Canadian Health Measures Survey 2007–2009.* Retrieved from http://www.fptdwg.ca/assets/PDF/CHMS/CHMS-E-tech.pdf

Irvine, J. D., Holve, S., & Schroth, R. (2011). Early childhood caries in Indigenous communities. *Paediatric Child Health, 16*(6), 351–357.

Leake, J., Jozzy, S., & Uswak, G. (2008). Severe dental caries, impacts and determinants among children 2–6 years of age in Inuvik Region, Northwest Territories, Canada. *Journal of the Canadian Dental Association, 74*(6), 519–519g.

Liepa, A., Urtane, I., Richmond, S., & Dunstan, F. (2003). Orthodontic treatment need in Latvia. *European Journal of Orthodontics, 25*(3), 279–284. doi:10.1093/ejo/25.3.279

Mouradian, W. E., Berg, J. H., & Somerman, M. J. (2003). Addressing disparities through dental-medical collaborations, Part I. The role of cultural competency in health disparities: Training of primary care medical practitioners in children's oral health. *Journal of Dental Education, 67*(8), 860–868.

Mouradian, W. E, & Corbin, S. B. (2003). Addressing health disparities through dental-medical collaborations, Part II. Cross-cutting themes in the care of special populations. *Journal of Dental Education*, *67*(12), 1320–1326.

Ngom, P. I., Diagne, F., Dieye, F., Diop-Ba, K., & Thiam, F. (2007). Orthodontic treatment need and demand in Senegalese school children aged 12–13 years—An appraisal using IOTN and ICON. *Angle Orthodontist, 77*(2), 323–330. doi:10.2319/0003-3219(2007)077[0323:otnadi]2.0.co;2

Nobile, C. G. A., Pavia, M., Fortunato, L., & Angelillo, I. F. (2007). Prevalence and factors related to malocclusion and orthodontic treatment need in children and adolescents in Italy. *European Journal of Public Health, 17*(6), 637–641. doi:10.1093/eurpub/ckm016

Onyeaso, C. O., & BeGole, E. A. (2006). Orthodontic treatment standard in an accredited graduate orthodontic clinic in North America assessed using the Index of Complexity, Outcome, and Need. *Hellenic Orthodontic Review, 9*(1), 23–34.

Peressini, S., Leake, J. L., Mayhall, J. T., Maar, M., & Trudeau, R. (2004a). Prevalence of dental caries among 7- and 13-year-old First Nations children, District of Manitoulin, Ontario. *Journal of the Canadian Dental Association, 70*(6), 382–382e.

Peressini, S., Leake, J. L., Mayhall, J. T., Maar, M., & Trudeau R. (2004b). Prevalence of early childhood caries among First Nations children, District of Manitoulin, Ontario. *International Journal of Paediatric Dentistry, 14*(2), 101–110.

Richmond, S., Aylott, N. A. S., Panahei, M. E. S., Rolfe, B., Harzer, W., & Tausche, E. (2001). A two-center comparison of orthodontist's perceptions of orthodontic treatment difficulty. *Angle Orthodontist, 71*(5), 404–410.

Schroth, R. J., Harrison, R. J., & Moffatt, M. E. (2009). Oral health of indigenous children and the influence of early childhood caries on childhood health and well-being. *Pediatric Clinics of North America, 56*(6), 1481–1499. doi:10.1016/j.pcl.2009.09.010

Schroth, R. J., Moore, P., & Brothwell, D. J. (2005). Prevalence of early childhood caries in four Manitoba communities. *Journal of the Canadian Dental Association, 71*(8), 567–567f.

Schroth, R. J., Smith, P. J., Whalen, J. C., Lekic, C., & Moffatt, M. E. (2005). Prevalence of caries among preschool-aged children in a northern Manitoba community. *Journal of the Canadian Dental Association, 71*(1), 27–27f.

Shaw, W. C., O'Brien, K. D., Richmond, S., & Brook, P. (1991). Quality control in orthodontics: Risk/benefit considerations. *British Dental Journal, 170*(1), 33–37.

Skidmore, K. J., Brook, K. J., Thomson, W. M., & Harding, W. J. (2006). Factors influencing treatment time in orthodontic patients. *American Journal of Orthodontics and Dentofacial Orthopedics, 129*(2), 230–238. doi:10.1016/j.ajodo.2005.10.003

Statistics Canada. (2007). *Aboriginal Peoples.* Retrieved from http://www41.statcan.gc.ca/2007/10000/ceb10000_000-eng.htm

Strauss, R. P., Stein, M. B., Edwards, J., & Nies, K. C. (2010). The impact of community-based dental education on students. *Journal of Dental Education, 74*(10 Suppl), S42–55.

Survey reveals disparities in oral health of First Nations [Editorial]. (2012). *Journal of the Canadian Dental Association, 78*, c143.

UBC Faculty of Dentistry. (2015). Community outreach [Web page]. Retrieved from http://www.dentistry.ubc.ca/donate/community-outreach/

Vu, C. Q., Roberts, W. E., Hartsfield, J. K., Jr., & Ofner, S. (2008). Treatment complexity index for assessing the relationship of treatment duration and outcomes in a graduate orthodontics clinic. *American Journal of Orthodontics and Dentofacial Orthopedics, 133*(1), 9.e1–9.e13. doi:10.1016/j.ajodo.2007.08.012

Woronuk, J. I., Pinchbeck, Y. J., & Walter, M. H. (2004). University of Alberta's dental students' outreach clinical experience: An evaluation of the program. *Journal of the Canadian Dental Association, 70*(4), 233–236.

Zammit, M. P. (1993). Malocclusion and orthodontic need in Labrador Inuit youth. *American Journal of Orthodontics and Dentofacial Orthopedics, 103*(2), 200. doi:10.1016/s0889-5406(05)81782-2

Zammit, M. P., Torres, A., Johnsen, D. C., & Hans, M. G. (1994). The prevalence and patterns of dental caries in Labrador Inuit youth. *Journal of Public Health Dentistry, 54*(3), 132–138. doi:10.1111/j.1752-7325.1994.tb01204.x