

# Changes in occupational health problems and adverse patient reactions in orthodontics from 1987 to 2000

Nils Jacobsen\* and Arne Hensten-Pettersen\*\*

\*Institute of Clinical Dentistry, Dental Faculty, University of Oslo, Norway, \*\*Scandinavian Institute of Dental Materials (NIOM), Haslum, Norway

**SUMMARY** The purpose of the present investigation was to assess the reasons for changes in occupational health problems and patient reactions to orthodontic treatment after a survey carried out in 1987. Questionnaire data on occupation-related health complaints and patient reactions over the preceding 2 years were obtained from 121 of 170 Norwegian orthodontists (71 per cent). Most health complaints were dermatoses of the hands and fingers related to the processing of acrylic removable appliances, to composite bonding materials, or gloves. A few reactions were of a respiratory or systemic nature. In total, occupation-related dermatoses were reported by 17.4 per cent (21/121) compared with 40 per cent previously. Non-dermal complaints comprised 9 per cent compared with 18.2 per cent in 1987.

Patient reactions were distributed equally between intra-oral reactions affecting lips, gingiva, oral mucosa, and tongue, and dermal reactions affecting the corner of the mouth, the dorsal part of the neck, the peri-oral area, cheeks, chin or skin elsewhere. A few patients had systemic reactions. The assumed eliciting agents of intra-oral reactions were fixed metallic appliances, acrylic removable appliances, polymer brackets or composite bonding materials, or were related to elastics. Extra-oral (dermal) reactions were attributed to metallic, elastic or textile parts of the extra-oral appliances. Some reactions were verified as allergies. The percentage of patient reactions in total was estimated to be 0.3–0.4 per cent compared with 0.8–0.9 per cent in 1987.

The reduction in occupation-related health complaints among orthodontists was explained by changes in previously important hygiene factors such as soaps, detergents, etc., whereas the biomaterials-related reactions persisted. The reduction in the 2 year incidence of patient reactions was associated with a marked reduction in extra-oral reactions following preventive measures such as coating metallic devices, whereas the intra-oral reactions persisted at the same level as previously.

## Introduction

Dermatoses and reactions affecting the respiratory tract or eyes among dental personnel are often caused by chemical factors associated with the running of a dental clinic or derived from exposure to biomaterials. For obvious reasons the occurrence of such reactions changes with the range of biomaterials employed and with the clinical routines followed (Hensten-Pettersen and Jacobsen, 1990). A questionnaire survey among Danish dentists (Munksgaard *et al.*, 1996) estimated the prevalence of skin symptoms to be approximately 38 per cent, of which 27 per cent were associated with their occupation. An important eliciting factor was acrylic resin. A similar survey among Swedish dentists showed a prevalence of dermatoses at a comparable level, supplemented with eye and respiratory tract reactions. The biomaterials which caused the most reactions were cold curing acrylates, primer, bonding, composite fissure sealants and glass ionomer, in order of observed frequency of reactions (Lönnroth and Shahnavaz, 1998a,b).

Surveys of this type provide useful information on cumulative irritant and allergic contact dermatoses, but the real proportion of allergic reactions is often difficult

to assess. However, in a questionnaire survey among Swedish dentists (Örtengren *et al.*, 1999) the reported reactions were followed-up by professional diagnostic appraisal of case histories, and by patch testing of a sample of dentists who had reported hand dermatitis (Wallenhammar *et al.*, 2000). A majority of the individuals were diagnosed as having irritant dermatitis. Twenty-eight per cent showed positive epicutaneous reactions to biomaterials-related allergens such as nickel sulphate, gold sodium thiosulphate, potassium dichromate, cobalt chloride, mercury, palladium chloride, colophonium, eugenol, formaldehyde, etc., and to a series of dimethacrylates.

Patient reactions related to dental biomaterials also occur, but at a considerably lower prevalence level (Kanerva *et al.*, 1994; Kanerva, 2001). Such reactions are often mucositis or gingivitis, sometimes with a burning sensation, pain and discomfort. It is assumed that such reactions are of a hypersensitive nature and may sometimes have a systemic component expressed as remote skin reactions. Disregarding the mercury/amalgam issue, the Norwegian Registry for Adverse Effects of Dental Materials showed that patient reactions for the year 2000 comprised resin-based materials, metals and materials for

short-time use in about equal magnitude. However, a reliable prevalence estimation is not possible because case reports from dentists or physicians are not obligatory (Björkman, 2001).

Orthodontic practice involves the use of biomaterial components known to release potential allergens such as metal ions from base metal alloys in fixed appliances, methyl-methacrylate monomers and other organic substances from chemically curing removables and resin-based bonding materials (Hensten-Pettersen and Jacobsen, 2003). Case reports and previous surveys have shown the occurrence of reactions associated with such allergens among both orthodontic patients and orthodontic personnel (Malmgren and Medin, 1981). In a survey among Norwegian orthodontists performed in 1987, a large percentage of orthodontic personnel had experienced adverse reactions of some type, especially associated with acrylic work and composite bonding materials. Their patients showed intra-oral and, in particular, extra-oral adverse reactions associated with similar factors and with the metallic part of fixed appliances on a level that exceeded that of other specialties (Jacobsen and Hensten-Pettersen, 1989, 1990). Since that time, clinical procedures and the diversity of biomaterials have changed in orthodontic practice.

The purpose of the present study was to reinvestigate the incidence of occupation-related adverse reactions in the same cohort of orthodontists as previously investigated and to describe the corresponding incidence of patient reactions observed by these orthodontists. The hypothesis was that improved clinical techniques and biomaterial quality would have reduced the incidence of adverse reactions in both categories.

## Materials and methods

### *The questionnaire*

Practising members of the Norwegian Association of Orthodontists up to 67 years of age were mailed a three page questionnaire together with a personalized introductory letter explaining the intention of the investigation. A reminder was mailed after 2 weeks and again after 5 weeks. The questionnaire consisted of 14 main points, including personal data (name optional). The occupational health problems could be described by choosing from a list of symptoms and locations characterizing dermal or other health problems experienced during the last 2 years. In addition, the questionnaire invited the participants to describe freely their experiences, and to relate the reactions, if possible, to clinical routines, materials, time periods, etc. The respondents were asked to provide information on subsequent medical diagnoses. Because the investigation focused on reactions to chemical factors related to orthodontic practice, no particular section of the questionnaire included questions related to musculoskeletal problems.

In addition, the orthodontists were asked to assess the number and nature of adverse reactions observed among their patients during the same time period and to relate them to materials or treatment procedures, using separate adverse effects forms. Moreover, the orthodontists were asked to estimate the number of (orthodontic) patients that were seen during this period of time.

### *Recording and treatment of data*

The occupation-related health problems were divided into dermal and non-dermal symptoms. Information on patient reactions was separated into extra-oral (dermal) and intra-oral/systemic reactions. The association between adverse reactions and materials or working processes indicated by the orthodontists was recorded as 'the assumed cause' of reactions.

All data on occupational health problems and patient reactions were recorded in tables according to the location/nature and assumed cause and ranged in descending order of frequency of observations. There was some overlap as sometimes one cause could lead to more than one type of reaction, whereas a reaction in one location was the result of only one cause. Care was taken that the questionnaire and the recording were similar and comparable with those used in the previous survey. Comparisons of the prevalence of occupation-related health complaints and patient reactions in the two surveys were performed with a  $\chi^2$  test of the appropriate proportions. When necessary, original data from the previous survey were used.

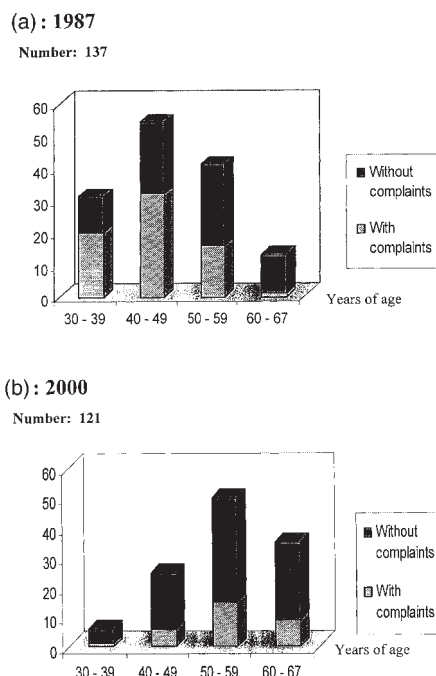
## Results

### *Response to the questionnaire*

Completed questionnaires were received from 121 orthodontists, 95 male and 26 female, of a total of 170 (71.2 per cent). One hundred of them (82.6 per cent) reported orthodontics as their only clinical work and eight more reported 90–99 per cent orthodontics. Of the remaining 13 individuals, 11 had a combined practice with a majority of orthodontics. All returned questionnaires were included in the investigation.

### *Gender, age, and occupational health problems*

The age of the responding orthodontists ranged from 32 to 67 years with a mean of 55.2 years, 48.3 years for female and 57 years for male practitioners. The mean age for both male and female orthodontists was 46.4 years in 1987, which was similar to data including non-respondents. The mean age was similar for orthodontists with or without health complaints. The age distribution is presented in Figure 1 with specific shading of individuals with occupation-related health complaints.



**Figure 1** Age distribution of Norwegian orthodontists in 1987 (a) and 2000 (b) with a distinction between individuals who had experienced occupation-related health complaints over the last 2 years and those who had not.

Thirty-one orthodontists had experienced such health reactions during the last 2 years. There was no information indicating differences between male and female orthodontists. Not counting individuals with musculo-skeletal complaints only, the percentage of health reactions among the orthodontists was 23 per cent in the recent survey, compared with 50.4 per cent in 1987.

#### *Nature, location, and cause of dermatoses*

The majority of the health complaints were dermatoses. Thirty reactions were reported by 21 orthodontists (17.4 per cent), ranging from a feeling of dryness, itching and reduced sensitivity to soreness, fissuring and pain. The corresponding ratio was 55/137 (40.1 per cent) in 1987, which represents a statistically significant decrease

( $P < 0.001$ ;  $\chi^2$  test). Most of the dermatoses were located at the tips, sides, dorsal parts of the fingers and hands, or to the nail beds. In addition, dermal reactions were reported for the face and on the arm, elbow, or ankle. In some cases the skin reactions could not be associated with specific causative factors beyond statements such as 'general allergies', 'dry air', 'worse in winter', etc. Others were associated with acrylate or composite-related work, or were glove related (Table 1). The most severe dermal reactions were located at the tips and sides of the fingers and were caused by composites or acrylates, presumably of an allergic nature. Two of these cases were confirmed to be allergic reactions to acrylic monomer by patch testing.

The following case illustrates a serious dermal reaction with a confirmed relationship to orthodontic materials. A 67-year-old male with 38 years of orthodontic practice had redness, eczema, desquamation, fissures and pain in the palms and the tips and sides of the first, second and third fingers on both hands. The nail beds were also affected. The reactions were caused by allergic reactions to acrylic monomers of cold curing acrylates and composite 'glues', according to medical expertise. The orthodontist has learned to avoid certain brands of these materials, by using only those that had caused the least reactions. Gloves reduced the reactions. He also had non-dermatological reactions such as cold, white fingers that he associated with extreme hand washing or with hand piece vibration.

#### *Non-dermal reactions*

Five orthodontists reported respiratory, systemic and eye reactions related to chemical factors such as biomaterials or the indoor climate. Two of these reactions were caused by grinding dust from acrylic work (Table 2). In some cases vasovagal/neurological reactions such as coldness, whiteness, numbness and tingling of one or more fingers were recorded without any particular explanation, although instrument vibration and glove effects were suggested. Although not requested, some orthodontists volunteered information on musculoskeletal reactions affecting shoulders, neck and the lower back,

**Table 1** Number of dermatoses among orthodontists according to location and assumed cause in descending order of frequency. Occasionally more than one location was recorded for each individual (30 reactions among 21 of 121 orthodontists = 17.4 per cent. The corresponding data from 1987 were 55/137 = 40.1 per cent, a significant difference  $P < 0.001$ ;  $\chi^2$  test).

Assumed cause	Finger tips, sides, palm	Back of hands, wrist	Fingers, dorsal side	Nail beds	Arm, elbow, ankle	Face	No. of orthodontists
General allergy or unspecified	1		2	2	1	2	7
Acrylic related	1	1		1	1		4
Composite related	4		3	1			4
Latex related		4			1		4
Soaps, detergents	2	2					2
Number of reactions	9	7	5	4	3	2	

**Table 2** Number of non-dermatological occupation-related health complaints among orthodontists according to the nature and assumed cause in descending order of frequency (23 reactions among 18 of 121 orthodontists = 14.8 per cent. The corresponding percentage in 1987 was 18.2 per cent).

Assumed cause	Musculoskeletal reactions	Neurological finger reactions	Systemic reactions	Eye reactions	Respiratory reactions	No. of orthodontists
Unspecified	1	4	1			5
Workload stress	2	1	4			4
Posture, equipment, etc.	4					4
Indoor climate, etc.		1			1	2
Acrylic related			1	1		2
Latex related				1	1	1
Number of reactions	7	6	6	2	2	

often combined with systemic reactions such as headache and dizziness. These complaints were most often attributed to workload stress and physical ergonomic factors. The following case descriptions illustrate some of these points.

1. A 39-year-old female orthodontist experienced tension headache, nausea and dizziness caused by workload stress, often leading to severe attacks of migraine. The migraine attacks were sometimes accompanied by white, cold, numb and prickling fingers of both hands. She needed partial or full sick leave during these attacks.
2. A 66-year-old male orthodontist with a post-poliomyelitis syndrome reacted with headache after grinding and polishing acrylic devices. The fumes and the smell initiated the headache and migraine, most often taking place towards the weekend. Reactions of this kind could also be caused by sudden flashes of light reflected from shiny surfaces such as mirrors, brackets, etc.

The percentage of orthodontists reporting non-dermal complaints was 14.8 per cent compared with 18.2 per cent in 1987. Disregarding the musculoskeletal factors listed in Table 2, the number of orthodontists with

non-dermatological complaints was 11 of 121 (9 per cent). In many cases, dermal and non-dermal reactions affected the same individual.

#### *Adverse reactions in orthodontic patients*

The number of orthodontic patients seen during the last 2 years was estimated to be 41 000 compared with 54 800 in the previous survey. Fifty-eight of the responding orthodontists described side-effects associated with the use of orthodontic devices in 129 patients. With few exceptions the patients were adolescents. The male/female ratio was 1:2.

The adverse effects comprised intra-oral reactions such as marked redness, swelling and soreness of the oral mucosa and palate and similar symptoms of the gingiva and lips. Occasionally reactions of a systemic nature, compatible with general allergic symptoms, were described. The assumed causes of the intra-oral reactions comprised the metal parts of fixed appliances, polymer-based activators, retention appliances and brackets, and latex-based elastics or gloves. In some cases specific parts of the appliances were identified (Table 3).

The systemic reactions included an anaphylactoid reaction to latex gloves, a case of fever accompanied by

**Table 3** Location and assumed cause of 83 intra-oral or systemic reactions in 74 of 41 000 orthodontic patients (0.18 per cent). The data are arranged in descending order of frequency. The corresponding ratio from 1987 was 67/54 800 (0.13 per cent).

Assumed cause	Lips	Gingiva	Oral mucosa	Tongue	Systemic reaction	Palate	Patients ( <i>n</i> = 74)
Fixed appliances, unspecified	24	14	8	2	1		44
Elastics, power chains, gloves		7		2	1		10
Acrylic removables, activators, retention appliances, polymeric brackets	3	2	2	2		2	9
Face bow	4						4
Nickel allergy	4						4
Nickel titanium upper bow	2		1				2
Composite	1				1		1
Activator spring				1			1
Reactions ( <i>n</i> = 83)	38	23	11	7	3	2	

blisters and swelling of the gingiva and lips following composite bonding, and headache/general malaise as a reaction to fixed appliances in an individual known to have a nickel allergy. These symptoms disappeared after discontinued contact with latex gloves, after changing the composite bonding material to glass ionomer, and after replacing stainless steel brackets/bows with titanium appliances. One asthmatic patient suffered severe breathing difficulties caused by the perfume worn by the dental nurse.

The extra-oral reactions comprised fissuring of the corners of the mouth, and redness, itching, rashes or eczema of the peri-oral area, the cheeks, chin, neck, scalp, earlobes and skin elsewhere. Occasionally rashes and swelling were seen in the peri-ocular region. The skin reactions were most often associated with extra-oral appliances having direct skin contact, such as face bows or neck pillows. However, in other subjects skin reactions were attributed to intra-oral devices such as brackets, bands and elastics (Table 4). Dermal and intra-oral reactions were often present in the same individual. When peri-oral reactions were combined with lip reactions, as was often the case, the effect was described by one of the orthodontists as 'similar to a circus clown'. Most of the reactions associated with the metallic parts of orthodontic appliances were either presumed to be a nickel allergy or were unexplained. However, seven cases were confirmed as a nickel allergy, all of them affecting girls.

In some cases a clear relationship was established between the orthodontic device and the reactions. A well-limited, dime-sized, smooth, red, painful spot developed on the tongue of a 13-year-old girl treated with an open activator during a 3 month period. The reaction was obviously caused by contact with a 1.2 mm hard stainless steel spring and disappeared 2 months after removal of the activator.

In other cases a more complex cause/reaction relationship was encountered. Intra-oral reactions in a nickel-sensitive girl associated with the insertion of

fixed orthodontic appliances could be attributed to nickel-containing earrings. In another girl treated with an orthodontic appliance containing stainless steel brackets and bands, fixed with composite bonding, serious peri-ocular and lip swelling and facial ulcerations could not be attributed to particular parts or specific materials.

#### *Incidence of patient reactions*

In addition to the reactions presented in Table 4, eight orthodontists gave information on observed gingival swelling ('oedematic', 'hypertrophic', 'hyperplastic') and frictional sores/fissures at the corner of the mouth of some patients without filling in the specific adverse reaction forms. This number was estimated to be 40 patients. The corresponding number from the 1987 survey was 75 patients.

Depending on exclusion or inclusion of the estimated number of patient reactions mentioned above, the 2 year incidence of adverse reactions reported in the year 2000 varied between 129/41 000 (0.3 per cent) and 169/41 000 (0.4 per cent). The corresponding data in 1987 were 417/54 800 (0.8 per cent) and 492/54 800 (0.9 per cent). The recorded dermal reactions amounted to 89/41 000 (0.2 per cent) compared with 350/54 800 (0.6 per cent) in 1987. The reduction in the incidence of patient reactions was statistically significant ( $P < 0.001$ ;  $\chi^2$  test), caused by a marked reduction in extra-oral reactions. The corresponding 2 year incidences of intra-oral/systemic reactions were 74/41 000 (0.18 per cent) and 67/54 800 (0.13 per cent).

#### **Discussion**

The validity of questionnaire information depends on the participants' motivation and their ability to recollect and describe the adverse reactions they have experienced. In both surveys, there was a considerable variation in the precision level, particularly with respect to the description of patient reactions. Other intrinsic pitfalls

**Table 4** Location and assumed cause of 95 extra-oral (dermal) reactions in 89 of 41 000 orthodontic patients (0.2 per cent). The data are arranged in descending order of frequency. The corresponding ratio from 1987 was 350/54 800 (0.6 per cent), a significant difference  $P < 0.001$  ( $\chi^2$  test).

Assumed cause	Corners of the mouth	Neck dorsal part	Peri-oral area	Face, cheek, chin	Skin elsewhere	Eyelids	Earlobes	Scalp, hair border	No. of patients ( $n = 89$ )
Extra-oral appliance									
Unspecified, or 'nickel allergy'	8		11	4	1	3	3	2	29
Anterior parts	24			3					28
Dorsal parts		16		1					16
Fixed appliance									
Metal brackets and bands	7				2				9
Elastics, ligatures	1		1	2					4
Removables, polymer brackets	2		2	1	1				3
Number of reactions ( $n = 95$ )	42	16	14	11	4	3	3	2	



may be associated with the comparison of questionnaire data collected over a fairly long time interval. The use of statistical methods for the evaluation of differences between the two surveys was therefore limited.

### *Occupation-related health complaints*

The personal data indicated that the number of practising orthodontists in Norway had decreased significantly in the period between the two surveys. The mean age had increased correspondingly, particularly among the male orthodontists, apparently because the majority of newcomer specialists were female. However, occupation-related health complaints, at least those caused by chemical factors, were experienced by orthodontists of both genders and in all age groups at equal rates.

The reduction in dermal complaints could be explained by a reduction in irritant factors such as hand washing, soaps, detergents, and indoor climate, prominent in the 1987 survey (Jacobsen and Hensten-Pettersen, 1989). It is conceivable that these changes are associated with an increased use of protective gloves. Hygiene-related factors often lead to dermal reactions of the dorsal parts of the hands and fingers as opposed to biomaterial-related factors that are more often associated with dermatoses of the corresponding ventral parts. Although protective for hygienic purposes, gloves are not impenetrable for many components from resin-based bonding materials (Munksgaard, 1992). Consequently, the tips and sides of the fingers and the palmar side of the hands have now replaced the dorsal areas of the hands and fingers as the most frequent location of dermal reactions (Table 1). With this background, the prevalence of biomaterial-related dermatoses among orthodontists was more similar in the two surveys than indicated by the reduction in the total prevalence of occupation-related dermatoses.

The biomaterials mentioned as causative factors in this context were composites and acrylic monomers. Strong circumstantial evidence indicated allergic reactions in many cases, although only two of them had been medically verified. In agreement with trends in several health professions, latex gloves were of increased importance as a cause of occupational dermatoses. The case histories presented by the orthodontists indicated that the latex reactions were either irritant or of the delayed type IV reaction nature, in agreement with findings among oral surgeons (Mebra and Hunter, 1998).

A comparison of the non-dermatological complaints in the two surveys did not reveal distinct qualitative differences. Acrylic-related work was still of importance for the occurrence of reactions of a systemic nature, or affecting eyes or the respiratory tract, although the number of such reactions was reduced. These reactions can be explained by volatiles associated with the

production of removable appliances, or by dust from debonding procedures.

The most serious occupation-related complaint among orthodontist appeared to be associated with hypersensitive reactions to resin-based materials in removable appliances and bonding materials after dermal contact. Known allergens, i.e. unreacted monomers such as dimethacrylates, hydroxyethylmethacrylate and methylmethacrylate, polymerization additives such as dibenzoyl peroxide, or dihydroxyethyl-p-toluidine, or reaction products such as formaldehyde, may explain some of the reactions (Kanerva *et al.*, 1994; Geurtsen, 2000). Increasing awareness of allergenic factors implies an increased use of protective gloves. The irony is that while gloves do not effectively prevent the penetration of bonding-related components, latex gloves represent a risk of unwanted dermal reactions *per se*. In addition, unreactive components from orthodontic materials may spread to the air in the dental clinic.

### *Patient reactions*

In both surveys the most frequent intra-oral reactions in orthodontic patients were located at the lips and gingiva, followed by the oral mucosa, tongue and palate. Most reactions were attributed to the metallic parts of fixed appliances, whereas acrylic devices and bonding composites caused between one sixth and one-fifth of such reactions. Reactions to elastics appeared to be more frequent in the most recent survey: 10 cases compared with one previously. Thus, the level of intra-oral reactions in orthodontic patients could be interpreted as fairly constant, with metal appliances still considered to be the most frequent cause. This is not unreasonable in view of the metallurgical problems associated with manufacturing orthodontic devices, such as stainless steel brackets, and the corrosive characteristics of brazing or soldering alloys still used in orthodontics (Matasa, 2000).

Reactions associated with resin-based materials are presumably caused by factors similar to those indicated above for the orthodontists themselves (Kanerva *et al.*, 1994; Geurtsen, 2000). Cross-reactions between different methacrylates and acrylates may contribute to the persistence of adverse reactions even if the individual composition of the polymer materials in orthodontics has changed over the years (Kanerva, 2001).

Latex allergies may comprise both delayed and immediate reactions depending on the actual latex-related allergen involved (Warshaw, 1998). Most of the latex-related reactions summarized in Tables 3 and 4 were related to elastic ligatures, but the orthodontists' gloves were also involved. In two subjects the reaction pattern caused by gloves was compatible with a type I immediate allergic reaction, one of them causing skin rashes and the other a syncope reaction.

The most marked difference between the two surveys was seen in the incidence of dermal reactions to the metallic parts of extra-oral appliances which reduced to about one-sixth of that in the 1987 survey. It is reasonable to suggest that this reduction was caused by the increased use of preventive measures such as plastic coating of extra-oral appliances, avoiding direct metal/skin contact. This view is supported by information offered by the orthodontists themselves, stating that metal reactions disappeared after changing to plastic-coated bows.

Although not always proven by objective tests, most allergic reactions to metal appliances, whether intra- or extra-oral, were associated with the release of nickel. Together with other allergenic metals such as chromium and cobalt, nickel is an indispensable part of stainless steel appliances, orthodontic solders and titanium-based bows. It is also accepted that small amounts of nickel are released by corrosive conditions in the oral cavity and moisturized skin. However, these facts cannot be interpreted to mean that orthodontically derived nickel is the primary sensitizer, at least not when released into the oral cavity. In fact, it has been discussed whether intra-oral nickel exposure following orthodontic treatment imparts a partial nickel tolerance that may prove useful for later exposures to nickel, i.e. by nickel-containing piercing devices (Lindsten and Kurol, 1997). Nor does it mean that nickel-sensitized individuals necessarily show any reactions to nickel-containing orthodontic appliances.

## Conclusions

On the basis of the information contained in the two surveys, orthodontics represents occupational challenges of a chemical nature similar to other branches of dentistry. Dermal reactions associated with soaps and detergents have decreased considerably over recent years, whereas reactions associated with biomaterials have persisted. Orthodontists seem to find their own individual solution to their occupation-related health problems. However, surveys of this kind do not reveal possible cases of early retirement.

Orthodontic treatment is generally uneventful as regards side-effects to orthodontic patients, considering the wide use of base metal alloys, and light or chemically curing acrylates, and natural latex, all products containing known allergens. However, unwanted side-effects do occur as intra- and extra-oral reactions. All reactions summarized, irritant as well as allergic, the rate of patient reactions in the most recent survey amounts to about 1 in 300. With the reservations stated above, this is a significant reduction from the rate found in the previous investigation. It is suggested that the reduction is a result of preventive measures such as coating extra-oral metallic devices leading to reduced extra-oral

reactions. The intra-oral reactions persist at a similar level, because no specific alterations in potential material-derived allergens have been made.

## Address for correspondence

Arne Hensten-Pettersen  
NIOM  
PO Box 70  
N-1305 Haslum  
Norway

## Acknowledgements

The participation of members of the Norwegian Association of Orthodontists is greatly appreciated. Special thanks are extended to the chairperson Dr Annlaug Stensland.

## References

- Björkman L 2001 Alle bivirkninger fra tannfyllingsmaterialer skal rapporteres til Bivirkningsgruppen i Bergen. Bivirkningsbladet, December: 2–3. UNIFOB, University of Bergen (Biannual information pamphlet from the Norwegian Registry for Adverse Effects of Dental Materials [www.uib.no/bivirkningsgruppen](http://www.uib.no/bivirkningsgruppen))
- Geurtsen W 2000 Biocompatibility of resin-modified filling materials. *Critical Reviews in Oral Biology and Medicine* 11: 333–355
- Hensten-Pettersen A, Jacobsen N 1990 The role of biomaterials as occupational hazards in dentistry. *International Dental Journal* 40: 159–166
- Hensten-Pettersen A, Jacobsen N 2003 Disintegration of orthodontic appliances *in vivo*. In: Eliades G, Eliades T, Brantley W A, Watts D C (eds) *In vivo* aging of dental biomaterials. Quintessence, Chicago, Chapter 9
- Jacobsen N, Hensten-Pettersen A 1989 Occupational health problems and adverse patient reactions in orthodontics. *European Journal of Orthodontics* 11: 254–264
- Jacobsen N, Hensten-Pettersen A 1990 Adverse reactions to biomaterials in specialty practice. *Transactions of the Society for Biomaterials* 12: 263 (abstract)
- Kanerva L 2001 Cross-reactions of multifunctional methacrylates and acrylates. *Acta Odontologica Scandinavica* 59: 320–329
- Kanerva L, Estlander T, Jolanki R 1994 Occupational skin reactions in the dental profession. *Dermatologic Clinics* 12: 517–531
- Lindsten R, Kurol J 1997 Orthodontic appliances in relation to nickel hypersensitivity. A review. *Fortschritte der Kieferorthopädie* 58: 100–108
- Lönnroth E-C, Shahnava H 1998a Adverse health reactions in skin, eyes, and respiratory tract among dental personnel in Sweden. *Swedish Dental Journal* 22: 33–45
- Lönnroth E-C, Shahnava H 1998b Atopic dermatitis, conjunctivitis, and hand dermatitis among Swedish dental personnel including use of personal protective devices. *Swedish Dental Journal* 22: 105–115
- Malmgren O, Medin L 1981 Överkänslighetsreaktioner vid användning av bonding-material inom orthodontivård. *Tandläkartidningen* 73: 544–546
- Matasa C G 2000 Tendances dans les biomatériaux orthodontiques: métaux et céramiques. *Orthodontie Française* 71: 335–341

- Mebra P, Hunter J H 1998 Latex allergy: a review of considerations for the oral and maxillofacial surgeon. *Journal of Oral Maxillofacial Surgery* 56: 1426–1430
- Munksgaard E C 1992 Permeability of protective gloves to (di)methacrylates in resinous dental materials. *Scandinavian Journal of Dental Research* 100: 189–192
- Munksgaard E C, Hansen E K, Engen T, Holm U 1996 Self reported occupational dermatological reactions among Danish dentists. *European Journal of Oral Sciences* 104: 396–402
- Örtengren U, Andreasson H, Karlsson S, Meding B, Barregård L 1999 Prevalence of self-reported hand eczema and skin symptoms associated with dental materials among Swedish dentists. *European Journal of Oral Sciences* 107: 496–505
- Wallenhammar L-M *et al.* 2000 Contact allergy and hand eczema in Swedish dentists. *Contact Dermatitis* 43: 192–199
- Warshaw E M 1998 Latex allergy. *Journal of the American Academy of Dermatology* 39: 1–24



Copyright of European Journal of Orthodontics is the property of Oxford University Press / UK and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.