Evaluation of damage to removable dentures in two cities in Finland

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The number of damaged dentures and type of damage to removable dentures repaired in dental laboratories was investigated using a questionnaire sent to 24 dental laboratories in Finland. Eight variables were examined for each damaged denture. The results showed that the type of dentures most commonly needing repair was the complete upper denture (49%). The most frequent type of damage was breakdown of the acrylic base and loosening of an artificial tooth. The chi-square test established a statistical dependence ($p < 0.005$) between damaged dentures and their age. Damaged upper partial dentures most frequently had natural teeth or fixed prostheses as antagonist teeth. Damaged lower skeletal dentures and acrylic partial dentures had a complete denture as the antagonist ($p < 0.05$). Removable dentures made of acrylic resin material seemed to break despite strengtheners, such as clasp wire.
□ *Breakdown; dentures; repair*

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Damage to a denture can occur either outside or inside the mouth. In terms of intraoral damage, the oral environment affects the denture both biochemically and mechanically. The chemical and biologic conditions within the mouth are related mainly to the composition of the saliva (1). The water in saliva is absorbed into polymer denture base and weakens it by plasticizing the material. Mechanical stresses to the denture are caused by mastication and the biting force. In humans the maximum biting force is approximately 640 N over all teeth and 265 N on a single tooth. The normal force on a single tooth is 3–18 N (2). Maximal bite forces in complete dentures are higher in the molar and premolar region than in the incisor or canine region of the dentition arch (3). Some factors have been thought to be related to increased biting force, such as a low Frankfort mandibular angle (4) and a small gonial angle (5). According to Schneider (6), in theory an edentulous patient could not fracture an acrylic denture base by mastication. However, a common problem has been recurrent midline fracture of the upper complete denture (7).

A midline fracture of an upper complete denture runs through the notch between the two central teeth, extending partially or completely through the denture base. The upper complete denture is affected to the extension at the posterior palate by mastication (8). While the denture base is deformed under the loading of the cyclic deformation during mastication flexural fatigue failure can occur. Farmer (9) has listed the clinical factors related to the failure of single dentures: 1) improperly contoured mandibular occlusal plane; 2) high frenulum attachment; 3) occlusal scheme; 4) occlusal forces; 5) denture foundation; and 6) thickness of the denture base. To provide harmonious occlusion with a denture, the natural teeth that will oppose a denture often require some degree of recontouring (10).

Because the structures of partial dentures are quite complex, such dentures are easily damaged. According to Nakazawa (11), the

Table 1. Data from questionnaire of dentures repaired and the list of variables, the nominal scale, and the frequency distribution of responses (n = 226, total)

Variable and nominal scale	No. of cases	%
Type of denture		
1. Upper complete denture with acrylic teeth	76	34
2. Upper complete denture with porcelain teeth	35	15
3. Lower complete denture with acrylic teeth	23	10
4. Lower complete denture with porcelain teeth	15	7
5. Upper acrylic partial denture	34	15
6. Lower acrylic partial denture	11	5
7. Upper skeletal denture	14	6
8. Lower skeletal denture	18	8
Missing	0	
Age of denture		
1. <1 year	20	9
2. 1–3 years	35	16
3. >3 years	169	75
Missing	2	
Wearer of denture		
1. Male	113	50
2. Female	113	50
Missing	0	
Cause of damage		
1. Mastication	137	61
2. Accident, trauma	89	39
Missing	0	
Type of damage		
1. Loosening of tooth	59	26
2. Breakage in acrylic base	145	64
3. Breakage in metal skeletal	11	5
4. Damaged clasp	7	3
5. Acrylic loosened from metal surface	4	2
Missing	0	
Type of antagonist		
1. Natural teeth or fixed prostheses	88	40
2. Complete denture	102	47
3. Partial denture	29	14
Missing	7	
Strengthener		
1. No	149	66
2. Clasp wire	55	24
3. Braided wire plate	13	6
4. Metal mesh	9	4
Missing	0	
City		
1. Lahti	126	56
2. Kuopio	100	44
Missing	0	

difference in fracture frequency between acrylic resin-based partial dentures and metal-based partial dentures is striking. Acrylic resin-based partial dentures fracture about four times as often as metal-based partial dentures do.

The aim of the present study was to determine the number and type of damaged removable dentures in two cities in Finland and to ascertain the statistical independence between certain variables and damage to dentures.

Materials and methods

The present study was conducted by determining the types of damaged removable dentures (complete dentures and acrylic and skeletal partial dentures) with a questionnaire (Table 1). The investigation included two Finnish cities (Lahti and Kuopio) and lasted 1 month. Approximately 200,000 inhabitants live within the sphere of influence of these cities, and the number of dental laboratories and denturist offices is 24. Information relating to 'the age of the denture', 'the cause of the damage', and 'the type of antagonist teeth' was obtained by interviewing and examining the patients.

The questionnaire consisted of eight variables, and the damaged dentures were evaluated on a nominal scale. In the statistical analysis the frequencies of responses on the nominal scale were calculated. The denture types were classified into four categories: upper complete dentures, lower complete dentures, acrylic resin partial dentures, and skeletal dentures. A chi-square test was used to establish the statistical independence (12) between variables in those categories of pooled denture type. The null hypothesis claimed that the variables were independent, whereas the alternative hypothesis claimed that the variables had statistical dependence. The results were presented as figures instead of contingency tables.

Results

Of the dental laboratories and denturist offices in Lahti and Kuopio, 58% returned the questionnaire. The total number of damaged dentures examined during a 1-month period was 226 (Table 1), and about the same number of repaired dentures per capita were reported in Lahti and in Kuopio. The frequency of male and female wearers of damaged dentures was equal.

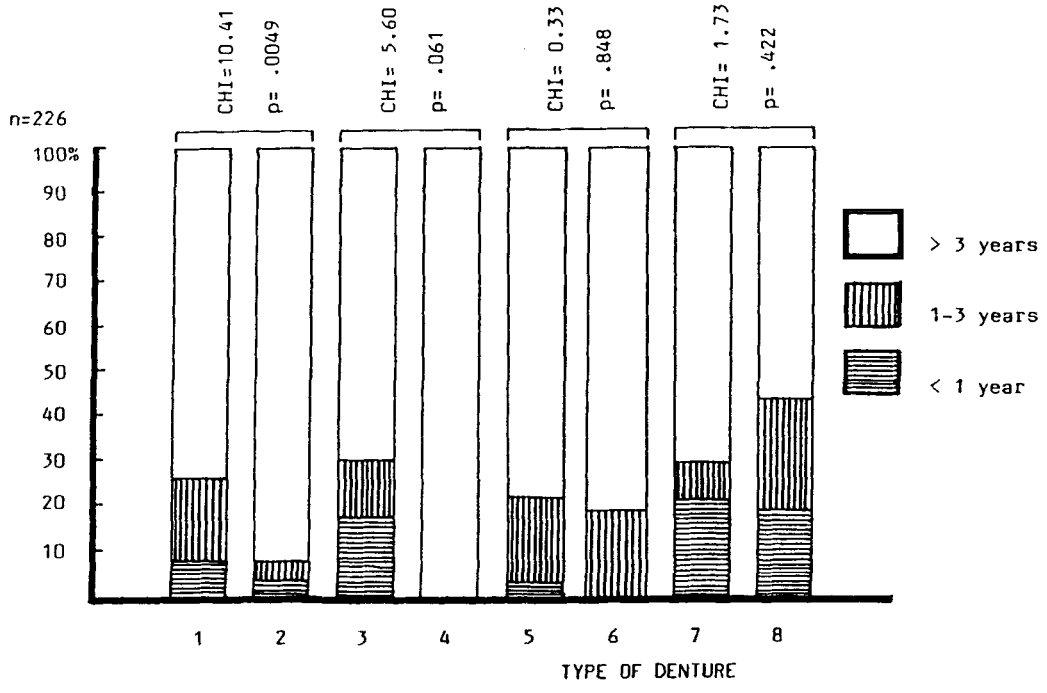

Fig. 1. Age distribution of damaged removable dentures. Types of dentures presented in Table 1. Chi-square test for independence used between four categories of pooled denture type and age of the dentures ($n = 226$, total).

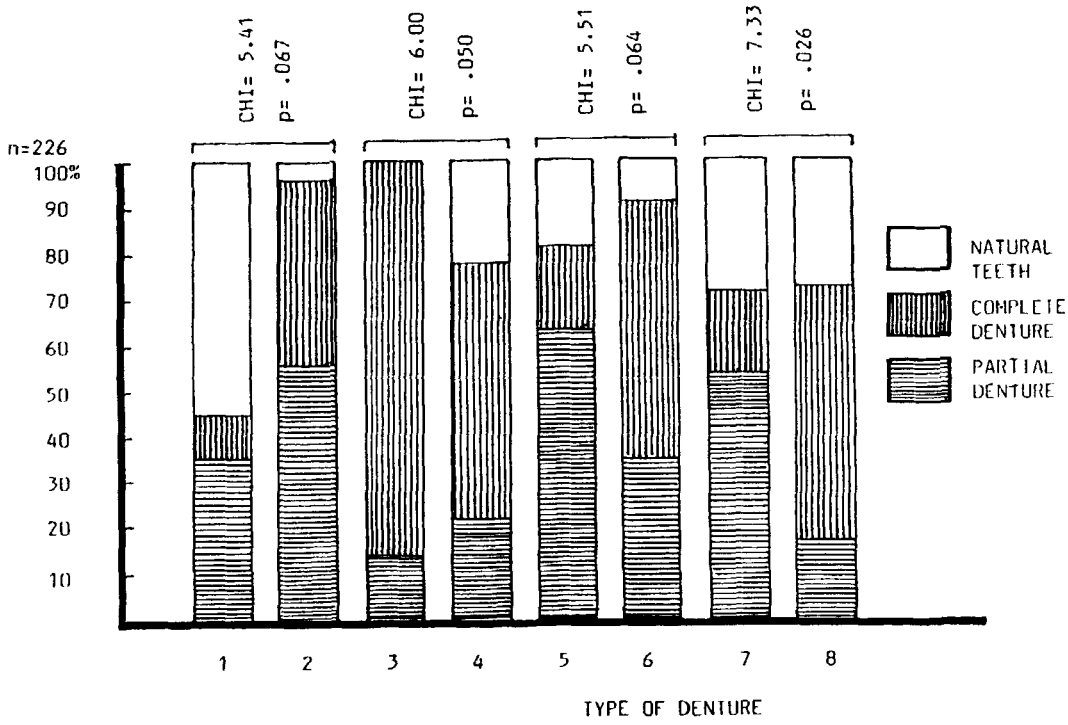

Fig. 2. Type of antagonists of damaged removable dentures. Types of dentures presented in Table 1. Chi-square test for independence used between four categories of pooled denture type and types of antagonist teeth ($n = 226$, total).

The commonest types of damaged dentures were upper complete dentures (49%) with acrylic or porcelain teeth and upper acrylic partial dentures (15%). According to the patients' reports, 61% of repaired dentures had broken during mastication. The commonest types of damage were breakdowns such as breakage or fracture of the acrylic base (64%) and loosening of teeth (26%).

As illustrated in Fig. 1, 94% of the damaged upper complete dentures with porcelain teeth had been in use more than 3 years. Of the upper complete dentures with acrylic teeth, 74% were more than 3 years old. Most of the other types of damaged dentures had also been in use that long. The chi-square test showed a statistical dependence between damaged upper complete dentures (pooled together) and age of the denture ($p < 0.005$).

According to Fig. 2, the variables 'type of antagonist' and 'type of denture' show that all types of antagonists opposed damaged upper complete dentures (pooled together). The lower complete dentures (pooled together) were most often damaged with a complete denture as antagonist. The acrylic partial dentures (pooled together) and the skeletal dentures (pooled together) were damaged most often with a complete denture or a partial denture as antagonist. The chi-square test established a low statistical dependence ($p < 0.5$) between these variables.

The commonest type (66%) of damage to upper complete dentures with porcelain teeth was loosening of an artificial tooth (Fig. 3). Breakage or fracture of the acrylic base was found in 75% of the damaged upper complete dentures with acrylic teeth. According to the chi-square test the statistical dependence was very significant between

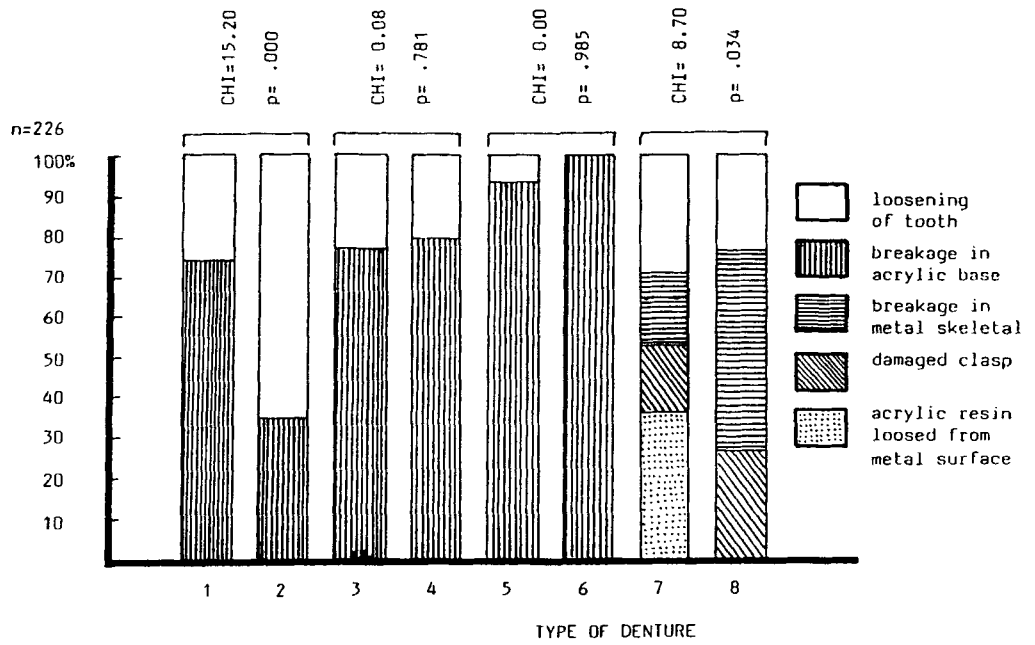

Fig. 3. Types of damage to removable dentures. Types of dentures presented in Table 1. Chi-square test for independence used between four categories of pooled denture type and types of damage (n = 226, total).

these variables ($p < 0.001$) (types 1 and 2 pooled together).

Of acrylic resin dentures needing repair, 34% contained a strengthener such as a clasp wire, braided wire plate, or metal mesh (Table 1).

Discussion

The results of the present study were obtained from 14 of the 24 dental laboratories and denturist offices (response rate was 58%). The present study did not include the damaged dentures repaired in a dental surgery. The number of such dentures is most likely quite small.

The strong occlusal biting force and the accompanying stresses on the dentures have been assumed to be the cause of denture damage. The study by Yli-Urpo et al. (13) established that most of the damage to dentures was found in single upper complete dentures with natural teeth as antagonist. Possible reasons for this were appraised to be a strong occlusal force by the natural antagonist teeth and uneven distribution of an occlusal bite force via the denture base. However, the present study failed to substantiate that suggestion, and the natural teeth or fixed prostheses as the antagonist had statistical dependence only with damaged upper acrylic partial dentures and with upper skeletal dentures. A statistical dependence between damaged lower complete dentures and lower skeletal dentures was found with a complete denture as the antagonist. This dependence is probably caused by the fact that lower complete dentures often occur with complete dentures as antagonist, and there may be no causal link between these variables. The common occurrence of the upper complete dentures with all the other types of antagonist teeth may also explain why no statistical dependence was found between damaged upper complete dentures and the variable 'type of antagonist'. Both natural teeth and complete dentures were reported to be antagonists of damaged upper complete dentures.

Because the biting force is stronger with the natural teeth than with complete dentures (4) and this causes damage to dentures, a dependence between these variables should be found with the chi-square test performed. The number of missing responses in the present study was highest for the variable 'type of antagonist'. This suggests that there might have been some misunderstanding about this variable, which might have affected the accuracy of the results.

Glantz & Stafford (14) postulated that there is no logical reason why loss of teeth should decrease the capacity of the chewing muscles to generate work. Electromyographic studies indicate that the muscular activity does not differ in dentate and edentulous persons. The above-mentioned authors found high local stress areas at the interface between complete dentures and the supporting tissues. Some other factors, however, are related to the diminished occlusal biting force with complete dentures, such as a feeling of pain from the alveolar mucosa and from the periosteum of the bones supporting the dentures.

One possible reason for damage to dentures is fatigue failure of the denture material. Fatigue failures do not require strong biting forces—low cyclic forces like those that occur during mastication can affect the fatigue of the material (9). Typical fatigue failure of upper complete dentures may be a midline fracture. Midline fractures are linked to poor fitting of complete dentures, which is caused by resorption of the residual ridges, whereas the palatal area of the maxillary bone remains unchanged. This combined with plasticity of the residual ridges (15) causes bending of the dentures during mastication. Resorption also causes poor retention of dentures. The speed of the resorption process can, in the beginning, be very rapid—for example, in maxillary immediate dentures (16). Consequently, rebasing or relining of dentures might be one possibility to diminish the fatigue of the denture material. In any case the denture wearer usually achieves a satisfactory level of adaptation to new dentures after 2 months (17), which may decrease the annual number of spontaneous requests for examination by a dentist.

Smith (7) and Hargreaves (18) have both indicated that midline fractures in dentures are most likely to occur after 2 to 3 years of use. The present study confirms that most upper complete dentures were damaged after 3 years of use. Other types of dentures also seem to become damaged after 3 years. This is in good agreement with the results of the study by Öwall et al. (19) carried out in Sweden. According to them, only a very few acrylic-based denture fractures were covered by the guarantee insurance scheme in 1989. The damages after a few years' use may indicate that fatigue of the denture material (polymer or metal alloy) is somehow linked to denture damage, but dimensional failures in laboratory technique of denture bases also predispose to damage. Chemical degradation of polymer in the oral environment weakens the denture, and this also predisposes it to damage.

Damage to removable dentures is quite frequent and provides much distress and cost for patients. These difficulties can best be prevented by regular examinations of the mouth and dentures. A new, more suitable method of reinforcing the base of dentures during preparation is also needed.

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